℞ FOR MEDICAL WRITING

A USEFUL GUIDE TO PRINCIPLES AND PRACTICE OF EFFECTIVE SCIENTIFIC WRITING AND ILLUSTRATION

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Quidquid Praecipies Esto Brevis

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True ease in writing comes from art, not chance,
As those move easiest who have learn'd to dance.

ALEXANDER POPE

PREFACE

Experienced and successful writers are agreed that writing is not a gift with which some are naturally endowed, but that proficient composition is a laboriously acquired skill. Good writing is one part inspiration and nine parts perspiration.

Many medical men and women seem to find the preparation of articles for publication an arduous task. Consequently the purpose of this book is to try to help them say what they mean and avoid—or eliminate—some of the faults in the final manuscript which may prevent the finished product from doing justice to the work on which it is based.

There are many excellent books on English composition, grammar and style which this manual makes no pretence of duplicating. If the suggestions presented here prove of some practical help to medical writers in the preparation of their papers it will be fulfilling its objective.

It will be understood that of the undersigned the first is responsible for the chapters on medical writing and statistics, and the second for the chapter on illustrations.

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CHAPTER 1 THE PRELIMINARIES

A medical paper is easier to write, and the final paper is more likely to be accepted, when the whole project has been carefully planned in advance. For this reason a discussion of medical writing can properly begin with some of those preliminary factors which help to determine whether the article will appear in print, and if it does how it will be received.

Choice of Subject

Possibly because so much of modern medical education involves memorization of previously accumulated factual information, many physicians find it hard to select a subject to investigate and write about. But until this is done there can be no progress toward the medical article.

How to Get Ideas

There are many ways of obtaining ideas for a suitable topic. Almost any medical meeting or conference will reveal points at which our knowledge stops or is deficient. Ask oneself the question "how?" or "why?" and a possible subject needing elucidation comes up at every turn. At one single hour long clinical conference I once jotted down eight subjects which might lend themselves to study and thus to an article. The current medical literature may be similarly employed as a source of ideas, disclosing gaps in knowledge which might be suitable for study and write up.

Observation of a patient or of groups of patients almost invariably suggests something which is imperfectly understood and therefore can be studied. The laboratory is just as fertile and for the inquiring mind the problem is to restrict the field of investigation rather than that of finding something to study. Not to be forgotten as a source of subject matter are discussions held with teachers or colleagues, where again conversation leads so often to the point of "I don't know."

From a list of subjects compiled in various ways one must select the one best suited to the time and facilities available. A

common failing is to be too ambitious and to start an investigation which will require more patients, more laboratory equipment or more time on the part of the worker than is likely to be available. Such factors as these as well as the skill and training of the writer must be weighed before making the final selection

Significance

The medical literature is already overburdened with papers which are merely rehashes of information previously published Hence it is important that the subject should be one which stands a reasonable chance of making a contribution to the advance of knowledge. In other words, the study and subsequent report should be significant. It may be difficult to anticipate the full significance of an investigative problem but the question should always be asked of oneself in advance What will the results of this study mean?' For example, a report based on the observation of three or four patients if articles describing several hundred similar cases are already in print does not stand much chance of being of enough significance to justify the effort of writing it! Some physicians are too critical of this factor and seem to feel that they should not write at all unless they can contribute something which would revolutionize accepted thought. But this is the work of genius, and most contributors to the literature must walk the tightrope between these two extremes

Timeliness

The subject chosen should be evaluated in advance for timeliness. A study which at one period is worthwhile and should be published, may at another time constitute a waste of valuable time. One example will serve to illustrate this point Soon after penicillin first became available many physicians started using it on their patients. The results, which were often spectacular were submitted in large numbers to medical journals in the form of reports of from one to a half dozen cases For the first few months —since these studies were the only source of information on the clinical actions of penicillin—most of them were accepted then came studies of larger groups under more controlled conditions of observation The result was that soon the authors of case reports just as good as those which had been accepted by the editors a short time before found their manuscripts promptly returned This factor of choosing the right time cannot be safely ignored if the

author does not wish to run the risk of having his work come to naught so far as publication is concerned.

Reading Up

Not long ago I read an excellent thesis prepared by a capable young physician who was just completing his training in a medical specialty. The work had been carefully done and was worthy of publication but for one defect: someone else had published an almost identical article about two years earlier! The young man had spent hundreds of hours on his paper and it was my unhappy duty to tell him of the existence of the published article.

This experience, which is by no means uncommon, illustrates the necessity of reading not only while the study is in progress, but also before the final selection of topic has been made. Textbooks occupy a distinctly secondary place for this purpose. They should be used merely as a guide to those original reports which the author of the textbook found important.

Access to the literature on a particular subject is best obtained in three ways: the *Quarterly Cumulative Index Medicus* published by the American Medical Association, the *Index Catalogue of the Surgeon General's Office*, and the bibliographies of the most recent and comprehensive articles on the topic under study. At the time of writing these words the first is neither quarterly nor cumulative and is distressingly far behind; nevertheless it offers the most complete list of references available up to the preceding two years or so. Every physician should become familiarized with it and should be able to track down any medical subject though it may be necessary to consult several subject headings in order to do so. The *Index Catalogue* is less useful for current material but it is nevertheless valuable, especially in finding references of historical note. Published articles on the subject selected for study are of immense value as a source of bibliography. The authors of such papers, however, have made their own selections and their own citations and interpretations so that it is always well for the prospective writer to read from original sources himself and to add new references, particularly those of most recent origin.

The list of references should be personally compiled. The pernicious habit of asking a secretary or even a medical librarian to prepare a list of references and make abstracts for use in the paper is dangerous. No one but the author can be expected to make a proper selection of articles, and even worse, shifting the responsibility in this manner nearly always leads to serious errors of fact

or interpretation which cannot fail to reflect on the reputation of the writer There are prolific writers who differ strongly on this point, claiming that their time is so valuable that they cannot look up the literature themselves this is an honest difference of opinion but, in my judgment, the quality of their publications suffers from the lack of personal attention to this important phase of their work

Recording Notes and References

Notes of reading, clinical or laboratory observations, and stray thoughts are lost or are likely to be inaccurate unless they are recorded in writing at the time. For this purpose some flexible system of note keeping is invaluable I like the method of using plain or line 5 by 8 inch cards (the 3 by 5 inch size is too small) which can be carried in the pocket. Excerpts or abstracts of references consulted can be made easily on these cards but the source should be accurately and uniformly placed on each card even when more than one notation is made from a single source. It is convenient to leave a wide space at the top so that the subject, e g. etiology pathology treatment can be entered later and perhaps changed once or twice Any data accumulated in this way can be reviewed from time to time, and subject headings may be entered shuffled and rearranged so that when writing begins the cards will be in the exact order to be followed in the composition

Planning the Study

An unplanned study almost invariably results in a disjointed final manuscript. One of the earliest steps in the preparation of a medical paper therefore, is to ask oneself two questions What point or points can be clarified by the proposed study?" and What evidence must be gathered to convince the reader?" This is not the place to analyze what constitutes scientific evidence. The most common failing, however consists of inadequate controls or none at all, and this is more true of clinical papers than of those presenting laboratory data. Ross, writing in the *Journal of the American Medical Association* reviewed 100 articles from five leading medical journals published during the first six months of 1950 and found 45 in which controls were not used 18 inadequately controlled 27 well controlled and 10 in which control was impossible This scarcely constitutes a record of which we can be proud

In addition to failure to use controls in many types of investigations where they could have been employed there are other frequent defects in planning the project For example anyone who

has attempted to compile a series of clinical observations from hospital charts accumulated over a period of years and recorded by a number of different physicians can testify that the information most desired is often lacking or is too vague to be of value. Furthermore, different observers do not always interpret the same clinical or even laboratory data in the same way. Hence, whenever possible, charts which are to be used to supply clinical data on a series of patients should provide space for the desired information and some sort of standard should be set up so that different observers will record their observations in the same way. Obviously this cannot be done *after* the patients have passed from observation.

The criteria which should apply to clinical studies bear with at least equal force when experimental evidence is to be presented. Controls must also be used, and phenomena observed must be as readily apparent to one trained investigator as to another.

All this is of fundamental importance to the medical manuscript because it vitally affects the quality of the end product and incidentally if the basic work has been adequately completed at the time writing starts, it makes the composition itself much easier.

Evaluating the Audience

Everyone has listened to talks or speeches which fell flat, not because they did not contain interesting and worthwhile information, but because they were not adapted to the particular audience or occasion. This is less common in published papers than in speeches, principally because editors stand in the way. However the writer who does not give thought to the kind of readers he aims to reach and the journal which is best fitted to do it risks rejection of what otherwise may be a fine paper. The writer must ask himself—even before preparing an outline—whether the information he has to present is best suited to the general practitioner, the specialist, the research worker or some other group. Arrangement and organization of material are particularly difficult if the author is aiming at mixed groups. Certainly both the scope and tone of the manuscript should be influenced by the anticipated audience.

Outlining

There is a sameness about an overwhelming majority of medical articles today which indicates that most writers follow the same structural outline and perhaps lack the literary courage to strike out for themselves. Introduction, history, etiology, pathology

pathogenesis clinical observations experimental observations, discussion summary and conclusions follow one another with monotonous regularity Not only does this similarity become boring but it leads to considerable difficulty in avoiding duplication and repetition The writer is often left in a quandary about whether to place some significant reference under history etiology pathogenesis, or discussion If the paper includes some pathologic observations, he is forced to decide whether to have *two* sections on that subject one involving the work of others and the other his own. If he decides on two, how is he going to compare his results with those of others without repeating?

I do not know how this curious rigidity has arisen but suspect that the current craze to examine medical students and doctors on every possible occasion has led to the establishment of a roughly similar formula which satisfies the examiner Whatever the cause I should like to plead for the discard of this set system But it is not safe to omit the outline before starting to write since this would lead to complete disorganization If there should be no absolute formula (and I for one believe there should not) how then can an outline be prepared? First the writer can ask himself what is the most important point that he wants to bring out in the paper With this question answered and jotted down in writing, an outline can be built which will carry the evidence in a convincing manner For example the author may omit entirely sections on history and etiology and include all that he wants to say on these subjects as he recounts his own observations or in the discussion. It is comparatively easy to juggle the outline headings until they satisfy the writer that everything he wants to say will be included Effort expended in this direction will prevent difficulty later when a decision must be made as to *where* in the paper particular observations or references are to go

Too many papers are submitted completely without headings Consequently it would be well if the outline headings were used as section headings in the completed work or at least submitted separately as a guide to the editor

CHAPTER II THE FIRST DRAFT

The Start

Most of us find that the hardest part of writing is getting started. Excuses for delay multiply like rabbits and lack of time tops all the rest. For the busy physician or surgeon this is no minor hurdle. Some meet the problem by hiding away from their patients and the telephone for an hour or two each day. Others leave town, rent a hotel room for several days, or burn the midnight oil. However accomplished, time must be found, for without the opportunity to concentrate which time alone provides good writing is unattainable.

With time set aside the dread moment comes eventually when the writer finds himself seated, pencil in hand, facing reams of virgin paper, his hands sweating mildly and his mind a blank. Is there anyone at this stage who does not wish that he had not committed himself?

The first few words are like a plunge into an ice cold pool. It isn't so bad after the start has been made. Each writer has his own methods. I like the rapidly written first draft, letting the faults creep in where they will and leaving their correction until later. This has the advantage of letting the writer warm up without constant interruption to the flow of thought and is less likely to lead to abrupt changes in pace or style. Every first draft, however, carries one particular danger for the medical writer: because he has worked hard on the composition, he all too often considers each word or phrase of the original draft as his own brain child and struggles against later changes or deletions as though they constituted infanticide.

Proper Length and Scope

Many authors, even before they start writing, are concerned about how long their paper should be. This question should be asked and answered, I think, *after* the paper has been written and not before. There is no standard: some papers of three pages are too long; others of twenty may be too short for the subject matter

to be presented. A safe rule of thumb is that a manuscript should be as long as is necessary to tell the author's story but not one word longer If there are definite space or word restrictions imposed by an editor or publisher—and this is not too frequent—the trimming of the paper or additions to it can be best accomplished during one of the revisions.

Some Early Don'ts

There are some important don'ts even in the first draft Reports from the clinical or pathologic laboratories, or from the department of roentgenology are commonly attached to patients charts They are not written for publication and to incorporate them verbatim in the paper is wholly undesirable. When such information is to be included the original report should always be rewritten and woven into the fabric of the paper

Occasionally I have encountered an author who assembled a mass of notes sorted them in rough order and turned them over to a medically untrained 'writer' to whip up into a paper True, some find it extraordinarily difficult to write and may need help *even in preparing the first draft, but the practice mentioned must* be condemned as avoiding the responsibilities of authorship A medical paper should be the composition of the author and not that of someone else.

With a detailed outline prepared and references, notes and data arranged on cards according to the outline it should not be too difficult to write freely and rapidly once the start has been made. The blank pages fill rapidly and before long the first draft is completed. Then comes the slow and difficult task of revising If Robert Louis Stevenson William Osler and a host of others could spend as much time and effort on their revisions as the records show *those of us who do not aspire so high certainly* should not resent the task. And the difference between a first class manuscript and a second class one comes from the revisions. What makes easy reading was *hard composing*

CHAPTER III. THE FIRST REVISION

There are as many ways of revising as there are writers. Consequently the suggestions which follow are made in the full realization that some writers will wish to make more revisions than those proposed some fewer and that different combinations will often prove more convenient or better suited to the particular occasion. Regardless of what method is followed, I would urge that the manuscript be set aside for a week or two before drafting the final copy in order to permit the subconscious mind to attack the subject and allow the paper to be viewed with fresh attention and interest. Those who do this never cease to be astonished by the errors they uncover and the improvements they can effect.

Four revisions of the medical paper are suggested as a minimum, but in each of them the author will need to review more than one aspect of his manuscript The first of these revisions may be directed at the paper as a whole. Is it adapted to the audience for which it is intended and the publication to which it is to be sent? These questions must be kept in the forefront of the mind while making the first critical rereading. At the same time, several other general features of the manuscript can be reviewed.

Balance and Proportion

A birdseye view of the first draft should readily reveal whether the material presented is properly balanced. Most first drafts contain too much of some features and not enough of others this is the time to shorten or expand the sections which need it. Some medical papers, for example, contain lengthy historical reviews several pages long, with only a page or two of case reports or other original contribution such a paper is out of balance and needs reorganization In other words, the *proportions* of the paper should bear a logical relationship to each other and to their relative importance to the whole

Expansion of those portions of the paper which need it does not usually present any serious difficulties, but shortening sections already written often constitutes a puzzling problem. One useful trick which may make the job easier is to bracket paragraphs or

to be presented A safe rule of thumb is that a manuscript should be as long as is necessary to tell the author s story but not one word longer If there are definite space or word restrictions im posed by an editor or publisher—and this is not too frequent—the trimming of the paper or additions to it can be best accomplished during one of the revisions.

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CHAPTER II THE SECOND REVISION

Style

In the second revision the style of the manuscript may be pondered. But what is style? There are as many different definitions as there are people who have written on the subject. For purposes of medical writing, at least, I doubt that it should be considered as some vague, unattainable object the acquisition of which is open only to the specially endowed. I like Canby's definition:

> style is the result of saying what has to be said as well as it can be said by you in your own way.

Matthew Arnold put it much the same:

> People think that I can teach them style. What stuff it all is. Have something to say and say it as clearly as you can. That is the only secret of style.

If such advice is sound—and it would be bold to quarrel with it—the effort in this revision of the manuscript can be directed toward making certain that each thought is expressed clearly and tells exactly what the writer means. Evidently many medical writers find this hard to do.

Obscure Writing—"Puddery"

The following is from the "You Can't Win" department of the New Yorker:

> We know, for example, that, as a general rule, the lean, asthenic type has an autonomic nervous system that is characterized by the preponderance of parasympathetic impulses to the viscera resulting often in the eventual production of such clinical syndromes as the asthma, or the gastric spasms and peptic ulcers; we know, by the same token, that the pyknic, bull-type person has operative functions that are predominantly sympathetic, producing eventually such clinical syndromes as the angina or general hypertension.

Or figure out this one:

> Determination of the structure of serotonin may reveal how blood vessel response to chemical agents is related to structural features which produce such a similarity in chemical reactivity.

sentences which might be omitted and then to look over the section as a whole to see if the deletions have helped If the bracketed portions can be omitted without harm they can be crossed out Another method of eliminating unnecessary material and bringing the paper into balance is to study the review of literature, which is so often longer than necessary When someone else has recently published a comprehensive review of the subject it is often sufficient to cite this source, with only those additions which have appeared more recently or which the writer particularly desires to emphasize *Balance cannot be defined in absolute terms and the author* shows his skill in achieving it in his writing very much as he might in his dancing or clinical work

Order and Emphasis

Some of my views on the order of presenting the material in a medical paper have been expressed *under the section on Outlining* (page 5) But a final look on whether the material is arranged to best advantage may be taken during this first revision This too is intimately connected with the nature of the report, the audience to which the paper is addressed and the point or points which the writer desires to emphasize On many occasions what the writer really wants to stress is buried deep in the paper where it is almost impossible to dig out It is well to ask oneself the question What do I most want the reader to get from this paper and is this so placed and so emphatically worded that there is no chance of missing it?' Emphasis can be obtained in several different ways by repetition by presenting the evidence in such sequence that the reader anxiously awaits the conclusion and by the arrangement of the paragraphs sentences and words Within the sentence emphasis can often be obtained by placing the key word at the beginning or end of the sentence rather than in the middle *Placing for emphasis applies also to the paragraph and indeed to* the arrangement of the paper as a whole

Omissions

Finally in the first revision the author might pay attention to whether he has left out anything which should have been included Here is the chance to make a final study of the literature, to check the clinical or laboratory observations, and to ask oneself whether the reader is likely to want to know about something left out which might just as well have been included. A transposition of identities is helpful if the writer can imagine himself the reader he may spot several things originally omitted but worth including

one-syllable thought into polysyllabic terms. Resist the impulse to say that men's clothing is machine made and write instead "Nearly all operations in the industry lend themselves to performance by machine, and all grades of men's clothing sold in significant quantity involve a very substantial amount of machine work." Put the obvious in the terms of the unintelligible. If the thought you wish to convey is that each article sent to the cleaner is handled separately, you can word this idea something like this: "Within the cleaning plant proper the business of the industry involves several well-defined processes, which, from the economic point of view, may be characterized simply by saying that most of them require separate handling of each individual garment or piece of material to be cleaned." Announce what you are going to say before you say it, or say what you have said after you say it. Finally, Williamson says, you must defend your style as scientific. Sneer at clear, simple English as popular or journalistic. "Explain your failure to put more mental sweat into your writing," he says, "on the ground that 'the social scientists who want to be scientific believe that we can have scientific description of human behavior and trustworthy predictions in the scientific sense only as we build adequate taxonomic systems for observable phenomena and symbolic systems for the manipulation of ideal and abstract entities.'"

It is all well and good to quote horrible examples of what someone else has written, but the medical author is often faced with getting rid of similar stuff in his own first draft—an entirely different proposition. There are ways of making this easier. One is to let a few days intervene between the writing of the first draft and the revision; this often permits finding and correcting poddery which had gone quite unnoticed at first. Another is to give the paper to a colleague to read and criticize; if this is done in good faith and the reader's comments are accepted without resentment the results are invaluable. Also the writer himself at this revision can scrutinize his paper for statements that are not clear and for repetitions in the text or for material which is duplicated by charts or tables. The latter form of repetition is extremely common among medical writers. It is unnecessary; the writer should decide whether the data he has to present can be grasped more easily by the reader in the form of tables, charts, photographs, or running description in the text. Once this has been decided it is not necessary to say everything twice, once in a table and again in the text.

Sir Ernest Gowers, whose father was so well known in neurology in his delightful book Plain Words, calls this kind of obscure writing puddery "The basic fault of present-day writing," he says is a tendency to say what one has to say in as complicated a way as possible. If the patient who came to exitus or progressed to fatal termination had just died some of our forests would have been preserved! "Don t say Quiller-Couch pointed out, He was conveyed to his place of residence in an intoxicated condition say He was carried home drunk

Puddery is apparently a failing of bureaucrats and sociologists as well as medical writers. Essentially puddery seems indistinguishable from padding and repetitiousness both of which reflect an uncertainty about what the author wants to say Gowers gives a wonderful example of saying at length what is so obvious that it need not have been said at all

> The planning of the Government Evacuation Scheme falls in o two parts (a) *the arrangements for the removal of persons from the* areas to be evacuated, and (b) the arrangements for their reception in the areas to which they are transferred. Those arrangements will not be of uniform concern to all local authorities, the arrangements for the removal being a matter for the authorities for the evacuation areas and the arrangements for reception for the authorities for the receiving areas.

Our profession has plenty of company Williamson has discussed the same subject in an article entitled How to Write Like a Social Scientist He says it has become a habit for social scientists to clothe their thoughts in smothering verbal garments As an example he gives this

> In the long run, developments in transportation, housing, optimum size of plant, etc., might tend to induce an industrial and demographic pattern similar to the one that consciousness of vulnerability would dictate. Such a tendency might be advanced by public persuasion and government inducement, and more effectively if the causes of urbanization had been carefully studied

Indeed there is no better statement on this subject than the six rules laid down by Williamson Never use a short word, he said when you can think of a long one. Always say currently rather than now sufficient instead of enough and 'termination instead of end Never use one word when you can use two or more If you can say "available evidence would tend to indicate that it is not unreasonable to suppose," use this instead of probably Put

one-syllable thought into polysyllabic terms. Resist the impulse to say that men's clothing is machine made and write instead "Nearly all operations in the industry lend themselves to performance by machine, and all grades of men's clothing sold in significant quantity involve a very substantial amount of machine work." Put the obvious in the terms of the unintelligible. If the thought you wish to convey is that each article sent to the cleaner is handled separately you can word this idea something like this "Within the cleaning plant proper the business of the industry involves several well-defined processes, which, from the economic point of view may be characterized simply by saying that most of them require separate handling of each individual garment or piece of material to be cleaned." Announce what you are going to say before you say it, or say what you have said after you say it. Finally Williamson says, you must defend your style as scientific. *Sneer at clear* simple English as popular or journalistic. "Explain your failure to put more mental sweat into your writing," he says, "on the ground that 'the social scientists who want to be scientific believe that we can have scientific description of human behavior and trustworthy predictions in the scientific sense only as we build adequate taxonomic systems for observable phenomena and symbolic systems for the manipulation of ideal and abstract entities.'"

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Jargon and Slang

There is a subtle but real difference between slang and jargon which some medical writers fail to appreciate Slang applies to words or expressions which are coined comparatively recently *because they contribute some color or shade of meaning* which cannot be so well expressed in any other way many English words and phrases which were originally slang are now in good usage and have greatly enriched the language Jargon refers to technical expressions used by a profession or cult which by no stretch of the *imagination* can be considered good *English* and which are often confusing, not only to those outside the fold but often also to those within it. 'The case went on a spree is an example of both spree was originally slang but is now clear and acceptable but case as used is jargon and the sentence is unacceptable.

Medicine, being a dynamic field of activity is constantly receiving new words some of which may be considered slang. These, if they clearly express a meaning which cannot be said as well in any other way and if this meaning will be clear to the reader may be left as written Occupational jargon however, which is so favored by current methods of writing patient histories and reporting hospital conversations must be ruthlessly deleted *from the written manuscript* Such things as using case instead of patient (or man woman, boy or girl) should never be allowed in print. To speak of gastroscoping, appendectomizing, or cystoscoping a patient is inexcusable. This kind of jargon is all too often carried over from careless speech into a written paper

*A few other careless expressions of the bedside or the labo*ratory which all too often creep into the manuscript are operate for operate *on* acute abdomen for acute condition within the abdomen appendix for appendicitis, diabetic for patient with diabetes (and cardiac nephritic, etc.) chronic ear for chronic *otitis media, specific* for syphilitic, lues for syphilis, gland for node normal solution for physiologic solution of sodium chloride 'popular for commonly used and negative for absence of abnormalities or negative result of test.

Fine Writing

Although not now as common as it used to be, medical writers *occasionally feel inspired to insert flights of literary fancy* into their manuscripts An autopsy report which says " the teeth sparkling like gems in the sunken countenance is hardly

appropriate to the subject. If a writer feels impelled to include phrases of this sort let him by all means put them in—and take them out at the first opportunity

A similar fault that sometimes gets into the first draft is the insertion of words or phrases in some dead or foreign language. This too has largely died a natural death, perhaps because of changed educational emphasis But this loss need not be mourned. Rarely is the use of foreign expressions more than an affectation. If such are found in the first draft they are better removed, except for those few which have no English equivalent.

CHAPTER 3 THE THIRD REVISION

In the third revision one can get down to the details and study the basic building blocks of the paper.

Paragraphs

Apparently the true function of the paragraph is not well understood. A paragraph should ordinarily contain several sentences connected by a common thought or theme. Medical papers are replete with paragraphs of almost unending length in which several different thoughts are expressed, often without logical order. It is not uncommon to read an article in which a single paragraph runs for two or three printed pages. This works a hardship on the reader who may be forgiven for turning elsewhere. Contrariwise, some writers seem to forget that the paragraph should be actually more than a single sentence unless the sentence is purposely set apart for emphasis. Single sentence paragraphs keep the reader constantly hopping about trying to follow the sequence of thought, and reading them is tiresome. In this revision, therefore, paragraphs can be constructed or reconstructed so that they will serve their true function of developing a thought out of several sentences and forming them so that the reader will find them easy to understand and follow with the eye.

Sentences

Medical writers seem to get more tangled up in their sentences than in any other part of composition. Part of the trouble seems to be the result of failure to realize that a single sentence should express only one thought. The common result is that sentences are often too long and so confusing as to be scarcely intelligible. The following is a remarkable example—it was contained in a paper actually submitted to a medical journal:

> A majority of them decided that, regardless of the pre-eminence of his college of graduation, of the number of degrees, inclusive of the M.D., he had attained, of the number of years he was professor of medicine or of surgery in the foremost medical college of the United States, of the number of years he served as house physician or house

surgeon for the largest and most completely equipped hospital in this country of the number of years he had been engaged in an extensive, reputable, ethical private practice of the number of recommendations for excellence of character and ability given him by reputable examining boards of other than basic science states, and regardless of the emergency of his present situation, as ill health or the illness of a member of his family necessitating removal to the more favorable climate or other conditions of a basic science state, such a thoroughly educated, qualified, but sorely distressed doctor must appear before a Basic Science Board, made up mostly of laymen, who know nothing about disease or the practice of medicine, and pass examinations in Anatomy Histology Pathology Bacteriology Physiology and Chemistry—(Some states omit one or another of such subjects and substitute Hygiene or Public Health)— with a general average of 75 per cent of correct answers, for which privilege he must pay a fee of $15 to $25 before he may appear before the medical examining board and apply for licensure through reciprocal endorsement of his examinations in the same identical subjects by his college of graduation and by the state board that issued his license to another state, for which reciprocal licensure he must pay another fee of $20 to $100 in order to be allowed to earn an honest living in the Basic Science State.

But shorter samples can be almost as bad This one, quoted by Gowers will surely strike a chord in the minds of all physicians who are also taxpayers

A deduction of tax may be claimed in respect of any person whom the individual maintains at his own expense, and who is (1) a relative of his, or of his wife, and incapacitated by old age or infirmity from maintaining himself or herself or (2) his or his wife s widowed mother whether incapacitated or not, or (3) his daughter who is resident with him and upon whose services he is compelled to depend by reason of old age or infirmity

In this third revision each sentence should be examined individually to make sure that it accurately expresses the author s meaning. In most awkward sentences the correction lies in shortening, since short sentences are easier to compose than long ones Rearrangement of words and phrases is often necessary All this is easier said than done and writers often have a bad time trying to revise a sentence which they know is bad Everyone, I think encounters this difficulty Sometimes it can be solved by giving up trying to revise the offending sentence and restating the thought on a fresh sheet of paper in an entirely different form This frequently ends the problem often the restatement does not even employ the same words In other instances I have found it helpful to break the sentence into two or more new ones with some rear

rangement of words or phrases. Usually this line of attack permits some deletions which further simplify the final form. Faced with an awkward sentence which is difficult to mend, the author should remember that he is not obliged to reword it in a single sentence merely because it was written that way originally.[1]

Words, Words, Words

The foundation of language, spoken or written, is the individual word and its positioning in the sentence. The rules of grammar are supposed to cover all this and make it easy but many of us have forgotten what grammar we may have known too grammar alone does not solve all problems of writing. Reading and practice improve the ability to select words and put them together but choosing the right word and using it in the right place is never easy.

I believe it impossible to teach how to select the right word it can only be learned. Yet there are methods of easing the job and also common faults to avoid, a knowledge of which may be useful to the medical writer. The first principle, perhaps is to choose a common word rather than an uncommon one, provided the former will serve as well. Many authors, particularly those in technical fields like medicine seem to feel that their colleagues will consider them more highly if they display their learning by using long and complicated words. Quite the reverse is true rare, archaic, or overlong words should be avoided unless they express an exact meaning which cannot be obtained in any other way.

For the selection of the right word a medical dictionary is indispensable. A good general dictionary is also useful to have at one's elbow. For finding the shades of meaning of closely related words I have found *Webster's Dictionary of Synonyms* extremely helpful. That book, or a thesaurus, can be used profitably to look up synonyms.

Placing the word in the proper place in the sentence—that is, the ordering of the words correctly—is quite as important. Strange things, indeed, can occur if attention is not paid to the arrangement in which the words appear as witness what Gowers obtained from a British weekly publication

> The official statement on the marriage of German prisoners with girls made in the House of Commons

Some problems in the use of words deserve special attention because our professional writings show a peculiar difficulty with them.

Plurals

Singular nouns with plural modifiers or plural verbs are not uncommon in medical papers The most common error of this nature is the use of the plural data as though it were singular *'This data is convincing* is so frequently seen that it passes almost unnoticed It should of course, be These data are Discord ances with phenomenon and phenomena are almost equally com mon. But these are not all Other plural subjects may be given singular verbs It is necessary therefore, to watch for such errors and correct them wherever found

Pronouns

Many medical writers appear allergic to the pronoun I apparently considering it as immodest and resort to almost any device to avoid it True, the reader might balk at too many first person singulars, but when an author is obviously referring to his own work or ideas and to none other he might as well say so When a writer uses 'we or one to refer obviously to himself alone he is indulging in an affectation of modesty which scarcely adds to the lucidity or honesty of his presentation Let us by all means *have more I s when that is what is meant.*

The we in contrast to the I tends to be used too much and often without any clear antecedent The 'we believe when written by a single author leaves the reader guessing as to what persons and how many hold that conviction We should be used only when it refers to two or more people who can be readily identified by the reader

It offers another problem So convenient and short a word is too handy It often appears after two or three antecedents and the reader is left to guess to which one it refers "It is obvious that it can no longer be necessary to employ this treatment and that other methods are preferable to it is a sample of too much it using.

Adjectives and Adverbs

The use of unnecessary adjectives and adverbs is a problem to practically all writers I do not know why this should be but it is perhaps an unconscious reflection of the author s desire to make his case as strong as possible In almost any medical manuscript one is astonished by the number of times marked very 'com paratively relatively many and other words of this sort appear

Note how often such words can be crossed out entirely with an actual strengthening of the statement. Adjectives and adverbs can be used sparingly at least in medical papers, but once put in are often removed with profit. 'Very' is an exceptionally weak word and can almost always be stricken 'marked' isn't much better and can usually be deleted or some stronger substitute found.

Nouns as Adjectives

The use of nouns as adjectives causes the purists of language a lot of distress. In scientific writing it seems that common sense is the only rule to follow since usage has made some nouns employed as adjectives more familiar and they sound less strained than the correct adjective. 'Skin cancer' for example, sounds better and more familiar than 'dermatologic cancer' 'heart disease' is more often used and is probably as correct today as 'cardiac disease.' On the other hand, 'ureter dilatation' is awkward as well as incorrect and 'ureteral' should be used.

An interesting series of letters on this subject appeared in *Science* several years ago The discussion centered largely around whether such a term as horse serum is good English. Frank C. Calkins, it seems to me, hit the nail on the head when he wrote

> No one blessed with horse sense would call it equine sense anyone who did might arouse a horse-laugh. And if a serum obtained from a horse is equine, one obtained from a donkey could only be asinine

It would be a mistake, however to conclude that it makes no difference whether a noun is used to modify a noun or not. Probably it is permissible to use nouns as modifiers only when suitable adjectives are not available or when usage has established the noun so firmly that the proper adjective sounds queer

Misused and Overused Words

Albutt, Fishbein and Hewitt have all compiled lists of words which medical writers commonly use wrongly or too often. Some are particularly objectionable Among these is the use of 'fact' when the author means conjecture or 'theory' Another is saying 'male' or 'female' when referring to men or women rather than animals. 'Case' for 'patient,' 'normal' for 'negative,' and 'popular' for 'widely used' are others which leap quickly to mind. Indeed, there are many others which *slip* by unless the author is on the lookout and eliminates them.

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All medical nomenclature is a dynamic and changing thing. It cannot and should not be frozen, because it is inescapably tied to advances in the science of medicine. Nevertheless there is a real advantage when medical men in one country can understand what those in another are talking about.

There are, I think, two principles which should be observed as closely as possible first, that the technical terms employed in scientific papers be those which are understood by all workers in the particular field as referring to the same thing in other words there should be no possibility of one person meaning one thing and one another Second, in those fields in which attention has been given to standardizing the technical nomenclature, the standard should be followed even at the expense of personal disagreement. Examples of standardization are the *B.N.A. Anatomical Nomenclature The Standard Nomenclature of Disease* and *The International List of Causes of Death*

Eponyms

The use of personal names as labels for diseases, syndromes, tests, or symptoms is common in medical writing. Many advances have come through individual effort and it is therefore not surprising that the names of those who have made original contributions should be attached to their discoveries. There are many objections, however to the use of eponyms in medical papers. The same form of hyperthyroidism is variously called Graves disease, Parry's disease von Basedow's disease, and Flajani's disease—depending on national prejudice. There are a Pott's fracture and a Pott's disease. There are three kinds of Pick's disease, each called after a different man with the same last name.

Eponyms are confusing and uninforming about the nature of the process or test to which they are attached. Their historical value may be learned better in other ways and it would be wise to eliminate them from published articles except in those few instances for which a descriptive term does not yet exist.

Abbreviations

Many medical manuscripts when they are submitted to the editor contain abbreviations which are hard to decipher Neither editor nor reader should have to be a cryptographer to find out what the writer is talking about, yet that sometimes happens. Few readers would quickly identify such abbreviations as M T P.P.D M.E.D or K.P unless they were using them them-

It is almost equally difficult to get rid of stock words which tend to be repeated over and over again That is certainly one word which scientific writers commonly use too often He stated that he told his physician that he had never had that trouble before is typical of the situation which can be encountered unless care is used with the thats

Split Infinitives

As I see it the rule against splitting infinitives is an arbitrary one which has been fought for so successfully by grammarians that the author departs from it at his peril It is a safe rule, and to avoid criticism it is easier to obey than to defy But perhaps it has received more attention than it deserves there are few literary craftsmen in whose writings one cannot find examples in which the rule has been broken For most of us, however it is better to conform

Circumlocution

Medical authors are prone to the use of circumlocutory expressions which I believe make them feel as though they had not committed themselves quite so much as the direct statement. In the case of 'with regard to it goes without saying (then why say it?), in the final analysis, it remains to comment on and similar opening expressions can usually be omitted or some single word employed to advantage It can be pointed out it must be emphasized that, and it is noteworthy that appear with amazing frequency in medical papers may their tribe decrease. In the majority of instances instead of most, and in some cases instead of the simple some have become part of our way of thinking. The author must make a conscious effort to free his writing of such circumlocutions

Scientific Terminology

The medical literature of all countries is plagued by confusion in technical terminology Latin Greek French English German Spanish Arabic and coined names are used by medical writers and frequently mixed up with each other so much that it is hard to know what the author is talking about Typical examples, such as the many terms used to describe clinical varieties of tuberculosis or arthritis are not far to seek Using lues in place of syphilis serves no purpose other than the possible confusion of a few patients—and not many at that

CHAPTER VI. THE BEGINNING AND THE END

Every medical writer should try to recall how he selects his own reading. Since the flow of medical literature is now so vast, no one can read everything. Most of us look first at the title, then the first few sentences and finally at the summary before deciding whether the whole paper is worth our time. If the writer wishes to entice more readers, therefore, he can devote his final revision to these three portions of the manuscript.

Titling

The title of a medical article ought to present the subject in as accurate and attractive a form as possible without attempting to make of it an abstract. Sometimes titles are short enough but meaningless. One such appeared in a leading medical journal simply as 'Clinical Experience. This leaves the reader completely in the dark—and the indexer will have to read the article to know where to classify it. A title such as Headaches would be nearly as bad for a periodical article since obviously the whole subject cannot be covered in a few pages.

More often the opposite fault is present and the title is too long and cumbersome Examples appear on every hand the following is not much worse than many others

WERNER'S SYNDROME (PROGERIA OF THE ADULT) AND ROTHMUND'S SYNDROME TWO TYPES OF CLOSELY RELATED HEREDOFAMILIAL ATROPHIC DERMATOSES WITH JUVENILE CATARACTS AND ENDOCRINE FEATURES A CRITICAL STUDY WITH FIVE NEW CASES

From the standpoint of the reader the main title should be short enough to be printed in one or two lines in the journal to which the article is sent. Sometimes the author is able to claim that he cannot give an adequate description of the subject discussed (and this is all that a title need attempt) in such a short space. If this is the case he may use a subhead underneath the

selves It is even more difficult to translate M T R into Meinicke flocculation reaction or PcB into near point of convergence Real errors, in fact, can result from such use of abbreviations For example E.coli can be interpreted either as Endamoeba coli or as Escherichia coli U C. can refer to urea clearance or urethral catheterization and quite likely other things Not long ago I picked up a medical history which said simply, "S O B climbing stairs." *It is well that physicians recognize shortness of breath when they* see it but the patient might find some cause to question his doctor s friendship!

Abbreviations lend themselves to dangerous mistakes and are unfair to the reader or manuscript editor In medical papers their use should be kept down and they are excusable only when their meaning has been explained the first time they appear so that there can be no possible cause for confusion—and they are justified by the space saved.

Punctuation

The stops of writing are for the purpose of making the reading easier They deserve more thought and study than can be given here, but there are many sources for this information In general medical writers do not overdo the dash or the parenthesis but they tend to use the comma too much They often forget the value of the semicolon and colon both of which may serve at times better than the period or comma. In choosing and placing stops there is no substitute for reading aloud what has been written the stops should fit with the rhythm of respiration as well as with the sense of what is said

Spelling

In these days *when secretaries and typists are taught to spell* and doctors are not it is by no means rare to find manuscripts which contain a considerable number of misspelled words When a physician writing in some field with which he is intimately familiar submits his paper to a medical editor with words in his own specialty misspelled the editor is inclined to wonder whether the other parts of the paper can be relied on if the writer is so careless in this respect Some argue that spelling is not important, but the fact remains that on borderline papers the editor may reach a decision to accept or reject because of such an unimportant point. Poor *spelling in a finished manuscript* is a sign of carelessness and is a responsibility which the author cannot avoid

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main title which can be set in smaller type and will not interfere with the attractiveness of the paper

Three examples of satisfactory titles follow

RESUSCITATION OF THE NEWBORN

DIAGNOSIS OF OBSCURE HYPERPARATHYROIDISM

PHYSIOLOGICAL EFFECTS OF VAGOTOMY
A STUDY OF THREE HUNDRED AND
THIRTY-ONE PATIENTS

The Opening

The first few sentences of an article should intrigue the reader and lead him on. If they do not attract or if they are obscure and confusing the reader will pass to some other article which may not contain as much real worth Time devoted to the start of the paper is thus well spent. An opening sentence like this does not do justice to the writer s subject

> Clinical evidence of pulmonary involvement in typhoid and the paratyphoid fevers is well recognized by most textbooks of medicine and the rather common occurrence of signs and symptoms of bronchial irritation which is usually referred to as bronchitis, as well as the possibility of complication by actual pneumonia are pointed out.

From this confusing statement it is hard to tell what the paper is about and probably at least half of those who would otherwise read it will shy away after this approach

A more experienced medical writer recently started out

> The important and difficult appraisal of the role of sympathectomy in the treatment of hypertension and hypertensive heart disease requires all the follow up information that is available.

This is a real come-on for the reader as is the following

> Frigidity is one of the most common problems in gynecology

Most writers take time to warm to their subject and consequently the opening sentences can rarely be left safely as they were originally written They will usually have to be completely rewritten Sometimes it seems almost impossible to revise the first paragraph into an attractive form Try starting with the second or third paragraph it is astonishing how often the original beginning can be removed entirely to the benefit of the paper

Summary and Conclusions

Most medical articles, with the exception of those which are purely reviews of the literature or case reports, close with a summary and sometimes with a section headed "Conclusions." A summary scarcely seems worthwhile for the reviews and if the titling has been done properly it is rarely desirable for a case report. For other articles, however, a well prepared summary greatly helps the busy reader in deciding what articles he wishes to peruse in full, in keeping up with developments outside his immediate fields of interest, or in searching the literature while building a bibliography for a paper of his own.

Unfortunately many summaries are not adequate for these purposes, chiefly because the author has not spent enough time and effort in condensing the material in the paper. It is exasperating to see a summary which starts out "The clinical data on forty cases of peptic ulcer have been reviewed." This tells the reader nothing about the results of the survey, which is the only thing he really wants to know. What the summary really should present are the most important results of the study, shorn of verbiage and yet adequately describing its nature; important negative results should be included along with the positive. To write a good summary is no easy task and time should be given to its preparation so that it will truly serve the purpose for which it is intended.

If the paper closes with a section headed "Conclusions," this should contain the author's deductions from the evidence presented in the paper only. It seems to me that many medical and scientific writers are too reluctant to draw conclusions from their work. True, they may get batted down later on by some colleague who finds flaws in the deductions or the evidence, but in the long run progress would be faster if more investigators, clinical as well as laboratory, showed greater willingness to commit themselves.

CHAPTER VII. SPECIAL PROBLEMS

A medical manuscript can be an original study, a review, a book, or a case report. Each of these presents special problems if the construction is to be such as will appeal to the reader and express accurately the thoughts and work of the author. Although the audience to which the manuscript is addressed must be constantly foremost in the writer's mind, there are frequently features of these various papers which have a common denominator and which may be solved in a similar manner.

Footnotes

The question of the desirability of footnotes, and if they are needed, the method of employing them, is not easily solved. Footnotes in scientific writing are merely instruments for the inclusion in the paper of material which the author feels should be available to the reader but which, if placed in the main body of the manuscript, is not part and parcel of the principal stream of argument or thought. Judged by such criteria it is always wise to cast a skeptical eye on *all* footnotes in order to determine whether their inclusion is necessary at all. If necessary, then perhaps they should be restored to an appropriate spot in the main body of the paper. Certainly nothing is more distracting to the reader than to come to a footnote which he wants to consult but to do so must drop his eyes on the page (or turn several pages), thus losing the thread of argument. The only excuse for the footnote that I can see is for the inclusion of material which ninety nine out of one hundred readers will skip but which is of paramount importance to some few students of the article. At worst the use of footnotes should be sparing and at best avoided.

Protocols

The reader has a right to know exactly how the writer conducted his experiments or observed his patients. The description of the writer's procedures and observations should, therefore, be included in the protocols of his manuscript. The trouble comes in

deciding how detailed the protocols should be There seems to be no arbitrary rule, and the discretion of the author must be employed The procedures and results of experiments need to be described carefully enough so that other investigators can duplicate exactly the conditions and can judge accurately whether the results of repeating the studies are comparable. Assuming the validity of this general principle, each protocol of an experiment must be considered individually it should be no longer or more detailed than is necessary to fulfill the requirements. Protocols of clinical observations may be similarly evaluated They should contain enough information to enable other observers to know exactly the kind of clinical subject studied, how this was done, what tests were made, and the criteria by which the results were measured A great fault in clinical protocols is the use of such terms of improvement as *marked moderate or slight* without defining their meaning in unmistakable terms. Perhaps this has held back the progress of clinical investigation by decades.

Bibliography

It should be assumed that the author of a paper for publication does extensive reading on the subject of his report but it is not always necessary for him to list everything he has read in the bibliography Nevertheless this is commonly done apparently in the mistaken belief that some professional colleague will jump to the conclusion that the writer is unfamiliar with the literature unless he has listed *everything* which has been written with even the most remote bearing on the subject This current policy is wasteful of time and paper with the exception of comprehensive reviews it is rarely necessary In many if not most medical manuscripts it is sufficient to record for publication those references only which are strictly applicable to the development of the writer s evidence and ideas If an adequate review of the literature has been published within a few years the bibliography attached to that paper can be cited Then it is necessary to add only those references which have appeared in the interim By following such a policy our medical journals will become less crowded with long lists of references many of which are unnecessary duplications and of dubious value to the reader

Too many present day bibliographies include references which have not been personally viewed by the writer This undesirable practice fails to take account of the fact that various readers obtain varied meanings from the same source It also leads to misunder

standing and to the perpetuation of errors, some of which can be extraordinary. The most unusual example of this type was described by Dobell in 1938, and editorialized in the *Journal of the American Medical Association*

> In January 1887 a paper was published by the late Dr. Jaroslav Hlava in the *Časopis lékařů českých* (Journal of the Czech Physicians) recording his discovery of amebas in the stools and intestinal ulcers of patients suffering from dysentery. He also reported success in causing dysentery in cats by the intrarectal inoculation of dysenteric stools. Dr. Hlava was professor of pathologic anatomy at Prague. While his paper of 1887, written wholly in the Czech language, was entitled "O úplavici, Předběžné sdělení," meaning "On Dysentery: Preliminary Communication," the original became known to most workers through a brief review in German signed by the late Dr. Stephanos Kartulis of Alexandria. By some extraordinary mistake the author's name (Hlava) was entirely omitted and the title of the paper was given in its place as "Uplavici, O." Kartulis in fact referred to the author personally as "Uplavici" and even mentions correspondence with a man of this peculiar name. In the contents of the Centralblatt in which Hlava's paper was abstracted the author's name is given as "Uplavici, O." In the subject index the name appears as "Hlava, Uplavici," but in the author index "Hlava" is the only entry, "Uplavici" having vanished without any explanation. The result has been that over the intervening years the authorship of this paper has been assigned variously to "O. Hlava" (instead of J. Hlava), to "Hlava, Uplavici" (as though Uplavici were Hlava's forename) and to "O. Hlava (O. Uplavici)," as though the two names were synonymous. In fact in a recent paper both Hlava and Uplavici are mentioned as though two different authorities had studied dysentery in cats in early days. Finally in the *Index Catalogue of Medical and Veterinary Zoology* Hlava's paper is first indexed with the wrong initial "O." but it is also attributed, without any explanation, to "Uplavici, O." and this name is followed by the further information "Dr." (in square brackets). As announced by Dobell, "Dr. O. Uplavici" is finally dead.

The meticulous consultant of the literature can quite easily pick up less remarkable examples of misspelled names, misquoted titles, and erroneous page listings which have been transmitted from one author to another merely because of failure to consult the original. If the original reference is not available or was not consulted it should be omitted or attributed as a citation to the source from which it was obtained.

The method of citing references in a scientific paper is a constant problem. If the author knows in advance what medical journal is going to publish his paper, he should conform his bibliography to the style of that periodical. This merely requires consulting a copy of the journal and following its style of listing

references or obtaining from the periodical in question its style book The listings in the bibliography should be uniform If the author does not submit them in this form, someone else will have to make them so

I have frequently been asked about quotations When excerpts are copied word for word from the writings of some other author they should be placed in quotation marks and the exact source acknowledged Articles and books usually have been copyrighted by the publisher so that permission to quote—or to reproduce illustrations—must be obtained by writing to the publisher and to the author Such permission is generally granted for any legitimate purpose. In many cases instead of direct quotation rewriting or paraphrasing what the other writer has said will serve as well as direct quotation in this event permission need not be obtained for use within limits prescribed by copyright law but the obligation to mention the source remains.

Case Reports

The case report occupies a peculiar and deserved role among medical articles. Many worthwhile clinical observations do not lend themselves to controlled or scientific study but deserve recording and can contribute to medical advance.

There are two types of case reports. In one the entire paper is built around observations on a single patient. In this type of report the best procedure is to start with a brief review of the literature citing only the most recent and important papers on the subject There is no standard length. What should be included depends on the circumstances Many such reports, however are too long and include a great deal of unnecessary descriptive material which does not add to the presentation Case reports therefore, in most instances should be short and pointed.

In the second type several similar cases are presented as part of a longer paper for the purpose of illustration Lengthy descriptions of results of examination should be avoided Only features of the case which are truly significant need to be recorded for publication and a simple statement to the effect that certain aspects of the physical examination or laboratory tests revealed nothing abnormal should suffice.

The use of the patient s real initials or of the hospital case number on the published case report is undesirable. If included these serve no useful purpose other than to raise the possibility that the patient could be identified and therefore subjected to

ridicule and a suit filed against the author. Of course, the author must keep a record, but it is both unnecessary and unwise to include identifying signposts to the patient's identity.

Editing and the Editor

Medical writers, like all others, are not infrequently annoyed by changes made in their papers by the editors of the periodical in which the article is to be published. Certainly the editor should represent the reader rather than the writer and as the reader's representative his first obligation is to accept only those papers which show real work and thought and which are presented in an understandable manner. Now this involves a rather rare type of judgment. An editor of a medical periodical cannot and should not reject material simply because it is new. If he does, he will be standing in the path of medical advance. On the other hand, if he accepts papers presenting new concepts which are not based on adequate evidence, he will be subjecting the readers of the periodical to a barrage of material which simply will not stand the test of time and may actually damage the standing of the periodical and the cause of medicine.

But this is not the only duty of the editor of which the writer should be aware. The editors of the *Journal of Clinical Investigation*, writing on this subject, said:

> We are in complete accord with the principle that it is not our function to dictate the style that an author should employ in the presentation of his studies. However, it is our function to take cognizance of the manner in which the data are presented, the care with which the deductions are derived, the validity of the references, as well as other factors which determine the acceptability of a manuscript. Irrespective of the degree of objectivity with which an editor or reviewer may wish to examine a manuscript, his attitude toward the data and deductions will be affected by the appearance of the manuscript and the manner in which it is written. When confronted with a sloppy manuscript he cannot help but wonder whether it reflects an inaccurate worker whose data are the results of careless experimentation.

Once a manuscript has been accepted, what then are the privileges and duties with respect to revision on the part of the editor and of the author? This is a difficult matter indeed and custom varies widely. Most of the popular magazines, once they have purchased an author's article, *feel* completely free to alter or rewrite it in any manner the editors see fit. At the opposite extreme are the editors of many medical and scientific journals who may

publish an article, once accepted, word for word as submitted in the obvious expectation that all faults and merits will be assigned to the author rather than to the journal

This wide difference of practice indicates that there are no definite rules of the game. In my opinion the editors of medical periodicals should take an intermediate position if a paper is believed by the editors to have merit but to require extensive changes. Before publication the manuscript should be returned to the author with suggestions of the editor given as specifically as possible, leaving any serious rewriting to the author If this is done the author should not be resentful, as is too often the case, but should realize that the editor is trying to assist him to prepare a more readable and better article. Even though the author may not agree with all the suggestions of the editor he is usually wise to follow them since the editor by reason of his profession is more likely to be familiar with the reaction of readers

With manuscripts which are acceptable and which need only minor changes rather than extensive revisions it is probably best for the editor or his assistants to make the necessary corrections, returning to the author not only the proof but the original manuscript In many of these cases, sentences or paragraphs which are not clear have been altered Authors justifiably resent it when such editing changes their meaning. Therefore, the conscientious editor or manuscript editor would do well to call the attention of the author to any rewordings introduced which might possibly change the thought the author wished to convey

Finally the medical writer should not ordinarily object to the minor editorial revisions which are made by the editors of any periodical or book publishing house in order to bring the manuscript into conformity with the particular style adopted by the publisher True the author may not agree with the style adopted but in submitting his manuscript he has tacitly consented to abide by the rules of the periodical or publisher in question

Form of Copy and Proofreading

The mechanical details connected with the submission of a manuscript for publication and the handling of proofs are not unimportant. Failure to know or observe the simple rules required works a hardship on the editor publisher and their staffs and is frequently detrimental to the interests of the author

All manuscripts submitted should be in final form and not preliminary drafts. They should be typewritten double space and

the original not the carbon copy sent in. The writing should be on one side of the page only on ordinary letter head sized paper with ample margins on the sides, top and bottom. Paragraphs should be indented and the pages should be numbered consecutively. It may seem strange to have to mention these rules but every editor has seen all of them broken—and other failings like dirty finger marks and illegible penciled corrections as well.

Since typists are not infallible, the author should read the final paper after the typing is done, no matter how sick he is of it by that time. Corrections of the final draft (if the page is not recopied) should be entered with the typewriter rather than by longhand. Lengthy additions (and there should not be many when the paper is this far along) can be typed on separate sheets and instructions given as to where they are to be inserted.

Rightly or wrongly typesetters and other members of the printing trades are more highly paid than typists. Consequently the cost of revisions once the type has been set is great. More and more medical journals and publishers are therefore passing on at least part of the cost of revisions made on proofs to the author this can be quite costly as well as wasteful in time and hard on the disposition.

Proofs when received should be read carefully and promptly. Figures, especially those for dosages, should be checked for accuracy as typesetters have been known to err. Changes in the proof should be made if necessary and of course, corrections indicated, but not more than required. The author should follow the markings given in the Appendix (p. 96). Most type is now set by machine and an entire line is set at one time. Consequently in correcting proof if the author can add about as many letters in a line as he takes out, or delete as many as he puts in, it may mean that only one or two lines will have to be reset instead of the entire part of the paragraph following the correction. Whenever feasible in the addition of material one should try to make such insertions at the ends of paragraphs rather than within them. These are minor points, perhaps, but their observance can save a good deal of time and expense.

The progress of the book will be expedited if certain mechanical procedures are followed: (1) write corrections clearly in pencil in the margin of galleys—not over the type itself. (2) avoid unnecessary comments or explanations in making changes. (3) answer all queries on the proof itself and do not change original copy to conform to galley corrections. (4) adopt queries by crossing

through the question mark only and reject queries by crossing through the whole query

It should be remembered that if the author has seen the proofs he is responsible for any errors they may contain regardless of where the errors may have occurred It is incumbent upon him, therefore, to give all proofs his close attention

HAPTER VIII. MAKING THE INDEX

Practically all medical books require an index to enable the reader to find rapidly and accurately those portions of the book which he wishes to consult. Many publishers, including the publisher of this volume, prefer to have the indexes of books prepared by their own experienced personnel even though a charge against the author's royalties must be made. Some authors, however, prefer to prepare, or at least supervise, their own indexes and these notes are made for their assistance or to aid them in checking an index which has been prepared elsewhere.

Good indexing is an art. The chief characteristics of the good indexer are (1) common sense, (2) the ability to divine the needs of those who will use the index, and (3) mastery of technic. Of these requirements, the most essential is good sense. Using it, one will avoid such references as these made by an unskilled indexer:

> *Chronic* ulcerative colitis (instead of under Colitis)
> *Types* of therapy in malaria
> *Site*, choice of, for vaccination
> *Incidence* of scarlet fever

Obviously there is no point in indexing under these catchwords. A safe rule is to put oneself in the place of the user. If you were using the book, under what heading would you expect to find the needed information?

How to Set About It

1. Get some cards about $2\frac{1}{2}$ by 4 inches if the entries are to be handwritten. If a typewriter is to be used perforated sheets are convenient, or regular typewriter size paper may be employed in such a manner that entries later may be cut apart in a uniform size for alphabetical rearrangement.

2. Obtain a book on a similar subject and with an index built upon a plan you have in mind for your book. This will help you lay out your scheme in advance.

through the question mark only and reject queries by crossing through the whole query

It should be remembered that if the author has seen the proofs he is responsible for any errors they may contain regardless of where the errors may have occurred. It is incumbent upon him therefore to give all proofs his close attention

Asthma
  bronchial and cardiac, 6_
  circulation time, 14
Bronchial asthma, in pulmonary heart disease, 899
Cardiac asthma, 114, 186
  differentiation from bronchial asthma, 70
  pathogenesis, 113
  treatment, 702, 207

Rather if it is decided to treat Asthma, bronchial' and Asthma, cardiac as the main entries, the catchwords Bronchial asthma and 'Cardiac asthma should carry only the cross references, *See* Asthma, bronchial' and *See* Asthma, cardiac respectively

4 Adjectives ordinarily need not be used as catchwords unless they have a special connotation which might be helpful to the user of the index. For example, Acute nephritis and Hypertrophic arthritis should be indexed only under the second words, but 'Glossopharyngeal neuralgia and 'Gonorrheal arthritis should be indexed under both. Anatomical adjectives should generally be changed to their parent nouns e.g., 'Cerebral tumor should be indexed as Brain, tumor Renal anomalies as Kidney anomalies, and Pulmonary abscess as 'Lung, abscess. All of these, of course, should also be entered under the second words e.g., Tumor of brain, etc. A cross reference may be made from the adjectival form if its importance warrants it.

5 Entries generally should consist of nouns (avoiding use of other parts of speech) as

Bacteria, identification, 225
Feces, examination, 378

Not

Bacteria, identifying, 225
Feces, how to examine, 378

6 As entries are written the logical variants should be formulated, giving a guide post to the material, on every term which might be sought by the reader as

Angina pectoris, cobra venom in, 101

and

Cobra venom in angina pectoris, 101

7 Special devices, such as a reference symbol abbreviation or a special type face with appropriate explanatory notes under

3 Take the *page* proofs of the book to be indexed having made certain that they correspond with the final pagination of the book contain any significant additions or deletions made in the text and show the transposition of any material that might have been moved then *underscore the topics to be indexed* with a colored pencil Such preliminary operation permits the formulation of over all policies before any entries are put on paper

4 Use a separate slip or separate space on regular typewriter paper for each item Select a heading that would be likely to occur to the user and under this heading put any subordinate entry that may be indicated, together with the page number In entering page numbers, *accuracy is vital* Keep on using fresh slips, no matter how often the same headings recur Do not waste time in trying to find a previous entry so as to add another folio number *The rearrangement of the entries will take care of itself when the* slips are alphabetized and edited

5 Include the number of entries necessary to give adequate coverage *of the material in the text—no more, no less.*

6 Omit the articles a and the when writing the entries Capitalize only the first letter and proper names.

Special Points

1 In small indexes, cross references should be avoided as much as possible but in a large work in which much information is grouped under well chosen heads it is well to have cross refer *ences from subordinate subjects or synonymous terms* Thus Arthritis hypertrophic. *See* Osteoarthritis, is an acceptable entry when the subentries are grouped under 'Osteoarthritis

2 *Consistency in terminology is of paramount importance* If synonyms for medical terms are used in the text all should be entered in the index, but page numbers and subentries should be concentrated under one, with the others cross referenced to this one. Common synonyms not actually mentioned in the text should be entered and referred to the term employed there.

3 Special caution should be exercised not to include some subentries in one place and different subentries in another (which seems to be a pitfall common to many authors) or in any way giving in one place part information which may be interpreted as the whole. For example, an index should not be filled with such entries as

Asthma
  bronchial and cardiac, 62
  circulation time, 147
Bronchial asthma, in pulmonary heart disease, 899
Cardiac asthma, 114, 186
  differentiation from bronchial asthma, 70
  pathogenesis, 113
  treatment, 202, 207

Rather if it is decided to treat "Asthma, bronchial" and "Asthma, cardiac" as the main entries, the catchwords "Bronchial asthma" and "Cardiac asthma" should carry only the cross references, "See Asthma, bronchial" and "See Asthma, cardiac" respectively.

4 Adjectives ordinarily need not be used as catchwords unless they have a special connotation which might be helpful to the user of the index. For example, "Acute nephritis" and "Hypertrophic arthritis" should be indexed only under the second words but "Glossopharyngeal neuralgia" and "Gonorrheal arthritis" should be indexed under both. Anatomical adjectives should generally be changed to their parent nouns, e.g., "Cerebral tumor" should be indexed as "Brain, tumor" "Renal anomalies" as "Kidney anomalies," and "Pulmonary abscess" as "Lung, abscess". All of these, of course, should also be entered under the second words, e.g., "Tumor of brain" etc. A cross reference may be made from the adjectival form if its importance warrants it.

5 Entries generally should consist of nouns (avoiding use of other parts of speech) as

Bacteria, identification, 225
Feces, examination, 378

Not

Bacteria, identifying, 225
Feces, how to examine, 378

6 As entries are written the logical variants should be formulated, giving a guide post to the material, on every term which might be sought by the reader, as

Angina pectoris, cobra venom in, 101

and

Cobra venom in angina pectoris, 101

Special devices, such as a reference symbol, abbreviation, or a special type face, with appropriate explanatory notes under

the heading of the index, may be used to denote pages which bear material to which special attention is called, or main discussions of the entry term as

Pneumonia, 305–336
  areas of consolidation in, 311*
  mortality in, 325t
  radiologic findings in, 318*

with an explanation such as

> Boldface type indicates pages bearing special discussion of the topic an asterisk indicates a page with illustration the letter t following a folio indicates tabular material

How to Alphabetize

1 Take the slips or cards and sort them into the twenty six letters of the alphabet, each in a separate pile. Now take the letter A and alphabetize the second letter of each word, placing Aa in one pile, Ab in another and so on The process is continued until *the alphabetical order is as accurate as a dictionary*

2. Single words constituting an entry with their subentries, should precede longer terms which begin with the same word, and both should precede longer words which begin with the same letters e g.

Tooth deciduous, 356
  examination 350
  extraction 166
  permanent, 360
Tooth pastes, 380
Toothache, 390

3 *Prepositions and conjunctions should* be ignored in the alphabetical rearrangement of subsidiary material and the entries alphabetized according to the principal words, as

Leukoplakia, 1691
  of bladder 2343
  differential diagnosis, 3211
  syphilitic, 3287
  of vulva, 2597

4 When the index material has been carded and alphabetized the next step is to go through the cards or slips from A to Z to make sure of the alphabetical order to eliminate duplicates and to combine entries common to various folios. Thus, suppose there are three slips, as follows

Aerobacter aerogenes, 19
Aerobacter aerogenes, 48
Aerobacter aerogenes, 46

the last two should be canceled and their folios entered on the first slip

Aerobacter aerogenes, 19 48 46

The material may be sent to the publisher at this stage. Typing, however is desirable, for a typed manuscript is more convenient for the printer and, with a carbon copy of the typed sheets, the danger of loss or destruction of the only available copy of the index is eliminated.

Typing the Index

In typing entries the catchword should be omitted on consecutive subentries, and the proper indentions should be followed. Indentions should be indicated which may be done as follows

Tooth, deciduous, 356
  [1] examination, 350
  extraction, 166
    [2] contraindications, 167
    hemorrhage following, 168

Such typed manuscript should be carefully rechecked against the marked page proofs to eliminate any possibility of error in entries or page numbers.

HAPTER IX. ILLUSTRATIONS

Illustrations are expensive to reproduce and therefore whether photographic prints, drawings or charts, the author should make his selections sparingly with due regard for their teaching potential and probability of faithful reproduction.

Good illustrations enhance the value of a book or of an article and no written text can ever be a satisfactory substitute. The great atlases of human anatomy dependent largely on illustrations for exposition, and the graphic contributions in the fields of surgery and pathology are striking examples.

To be of the greatest value, illustrations should be designed with a specific audience in mind. Illustrations intended for the use of physicians and medical students are frequently unsuitable for other special and even associated groups.

Emphasis is an important aspect of illustrations. In many illustrations there are areas or points of relative first importance which should be stressed (Fig. 1).

The originals of illustrations are always preferred for publication and the author should not submit photographic copies if he has the originals or can obtain them. Too often photographic copies (Figs. 2, 3) and printed reproductions of even the simpler kinds of charts and diagrams are faulty from the view of satisfactory engraving results.

The Preparation of Illustrations in General

Authors and illustrators may assume that publishers will be happy to cooperate with them. If information is wanted concerning any aspect of the reproduction and printing of illustrations, the publisher will gladly supply it.

In the preparation of illustrations for publication the first considerations are the space available (Fig. 4) to accommodate the reproductions and the type of paper which will be used in printing. Thin paper stock and uncoated papers suggest the use of line drawings so far as feasible since halftones (which require coated stock) may complicate printing and binding. Line technics

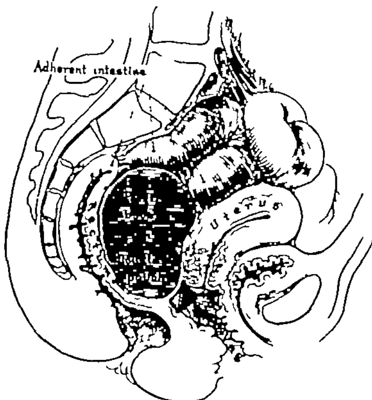


Fig. 1 Illustration by Max Brodel showing emphasis of the area of interest and relative simpler treatment of the anatomic relationships. (Cullen Surgery Gynecology and Obstetrics.)

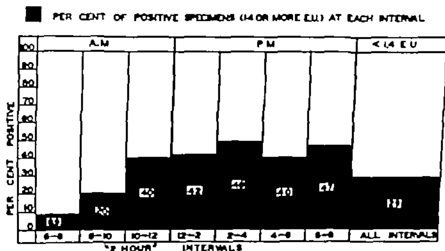


Fig. 2. Reproduction from a photograph of the original chart Filling in and spreading caused to some extent by intermediate photography are evident. (From Neefe in Medical Clinics of North America.)



Fig 3 *Left* Line engraving from the original illustration. *Right* Reproduction from a rather good photographic copy of the drawing. The difference in quality of the two engravings is easily discerned. (By permission of Dr Barry J Anson.)

are cheaper to reproduce than tone methods Tone methods lend themselves more readily to realistic representations than line technics. The greater proficiency of the illustrator in the handling of one method over another may be the factor which should decide the choice of medium.

The size of the *original* illustrations is not highly important except that in a related series a certain consistency is desirable for uniformity of reduction. The size of the lettering in all labels, however should be carefully considered from the view of size when reproduced. Lack of uniformity of printed labels is particularly noticeable and disturbing.

Careful grouping (Fig. 5) of illustrations and the use of inserts (Fig. 6) save engraving expense and sometimes will utilize space which otherwise would be wasted. Photographic material is especially suitable for grouping since frequently several prints may be adjusted by trimming (cropping) to fit definite spaces without harm to their value as illustrations (Figs. 7 8) Drawings (which cannot be cropped) when drawn as separated figures, are less adaptable to grouping by the publisher than photographs. To use the space on a page advantageously drawings should be prepared as a group by the illustrator

If the author and the publisher agree that it is advisable to use an overlay of color in order to differentiate the areas of an illustration or perhaps the structures shown, the overlays should be prepared separately in black. The portions of the illustration to

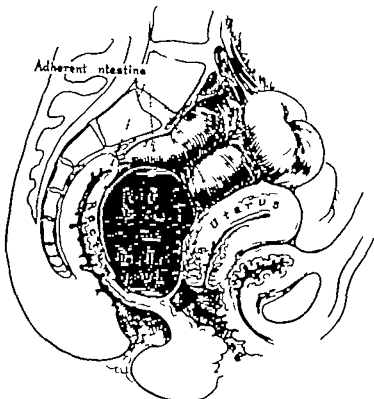


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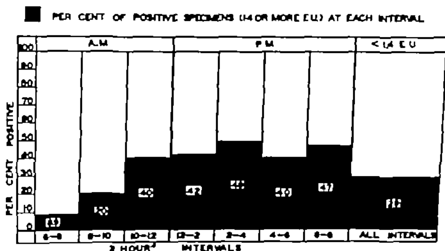


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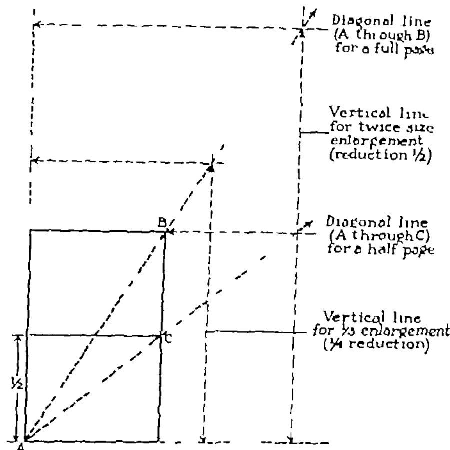


Fig. 4 How to scale the size of illustrations to the known proportions of a type page or type column (shaded area) *A reverse procedure will determine the linear proportions of an illustration when it is reduced*

receive a color should be traced on a substantial transparent material or else inked on engraver's proof which has been printed in light blue The latter method requires engraving of the illustration first. In making the overlays, the printed tone may be varied by utilizing line technics, mechanical (Fig. 9) and handmade, instead of unbroken black alone. The basic picture must be kept rather light in tone value if the color is to be effective when printed

Correlation of illustrations and written text is most desirable and consequently the author should furnish a copy of his manuscript to the illustrator whenever possible

Identification of Illustrations

To save possible confusion and correspondence, the author should write on the *back* of each illustration his name, the figure

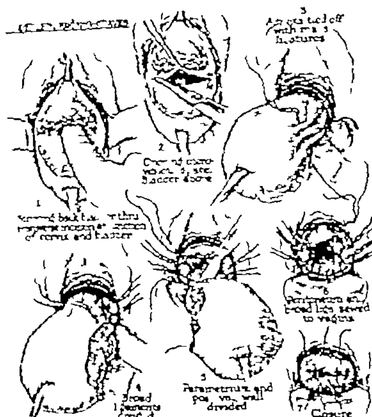


Fig. 5 Surgical procedure illustrations prepared as a group, by Tom Jones an excellent example of economy in the use of space. The original of the group 10 by 10 inches, was drawn for one-half reduction, a somewhat larger size than is shown here. In this instance no accompanying legend except the title "Vaginal Hysterectomy" was necessary since the surgical steps were described in the labels. The label under the initial drawing (1) obviated the use of another picture to show the actual line of incision. (Vaginal Hysterectomy Surgical Procedure, 8th Ed., by permission of Ethicon Suture Laboratories, Inc.)

number and the subject of the picture he should designate the desired location in relation to text and refer to each illustration at the proper point in the text.

Preparation of Photographs

The preparation of photographs for medical publication is the province of the clinical photographer. Indifferent prints too often

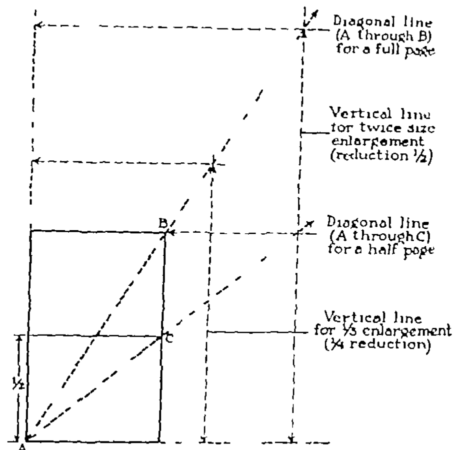


Fig. 4 How to scale the size of illustrations to the known proportions of a type page or type column (shaded area) A reverse procedure will determine the linear proportions of an illustration when it is reduced.

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To save possible confusion and correspondence the author should write on the *back* of each illustration his name, the figure



Fig. 7 Four directly related photographs trimmed and arranged by the editor for engraving on one plate. The reference letters to the individual pictures have been placed and instructions to the engraver indicated.

If for the purposes of orientation, it is necessary to include nonessentials, the lighting should be adjusted in order to emphasize the essential features.

Enough distance between camera and subject is important. When they are too close together the resultant foreshortening [illegible] appear as a distortion.

Negatives

Spots must be eliminated or the prints [illegible] touched. The unwanted areas should be covered with [illegible] paint if white on the print will provide a better [illegible]

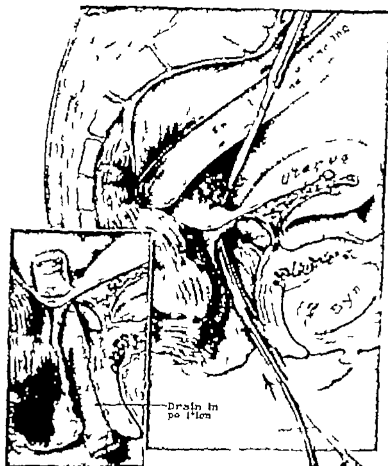


Fig. 6 The use of an insert to show a secondary step of a surgical procedure Drawing by Leon Schlossberg. (Wharton Gynecology)

reflect inexperience with the camera and a lack of appreciation of the purposes and limitations of photography For those with little experience the following suggestions are offered

The background and the subject should be in sufficient sharp contrast to emphasize the desired features Flat unbroken back grounds are really best. Strong, peripheral shadows on the subject are likely to merge with a black background with a consequent loss of contour of the subject With a brilliant marginal light on the subject against a white background the contour of the subject will be weakened because of a lack of contrast

Extrinsic objects and appurtenances divert attention from the point of interest So far as possible the picture should be limited to the area of interest.



Fig. 7. Four directly related photographs trimmed and arranged by the editor for engraving on one plate. The reference letters to the individual pictures have been placed and instructions to the engraver indicated.

If for the purposes of orientation, it is necessary to include nonessentials, the lighting should be adjusted in order to emphasize the essential features.

Enough distance between camera and subject is important. When they are too close together the resultant foreshortening may appear as a distortion.

Negatives

Spots must be eliminated or the prints will have to be retouched. The unwanted areas should be covered with opaque paint if white on the print will provide a better contrast.

Fig. 8 Same group as Fig. 7 The final cropping and white outlines were done by the engraver

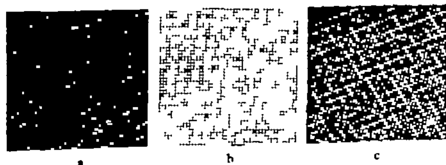


Fig. 9 *a*, *b*, Two of the many printed patterns of shading film which may be utilized for purposes of differentiation *c* The two patterns have been overlapped, producing a third pattern.

Prints

Prints 5 by 7 inches (including roentgenograms) are preferred by some publishers since the size approximates that of the type page of the ordinary journal or book, and the reduction will be slight to accommodate the picture to the column.

Glossy surface paper is desirable. A print should not be mounted if it is likely to be combined with other prints or other art work. The author should indicate with wax pencil (easily erased) where straight (across and up-and-down) cropping is feasible. Sequence letters, labels and any other added designation marks should be inserted in strong contrast to the immediate surrounding area—black in light areas, white in dark areas (Fig. 8). Do not use colored inks, especially blue, which become much lighter when photographed.

Paper clips and pins injure the surface of a print and should be avoided over the area to be reproduced. Adhesives, if removal is necessary, may remove the surface of the print. A pen or soft pencil should be used for writing notations on the back of a print marks made with pressure will raise the surface of the front.

Photomicrographs

When the publication of large photomicrographs is desired, the author should decide on the essential field in relation to its accommodation on the page, and either crop the print accordingly or to guide the editor mark with a wax pencil the limits of cropping. The latter procedure is usually preferable unless the author has gauged to a nicety the necessary reduction.

Small photomicrographs are unlikely to require much reduction or may need none at all, thus permitting the retention of the original magnification. Small prints are used effectively in combination with large photomicrographs or other illustrative material from the same patient or subject—that is, superimposed on an unimportant area (Fig. 10). The cost of engraving is reduced in this way.

The magnification of photomicrographs should not be designated on the prints but indicated instead in the accompanying legends which may be corrected after the prints have been reproduced.

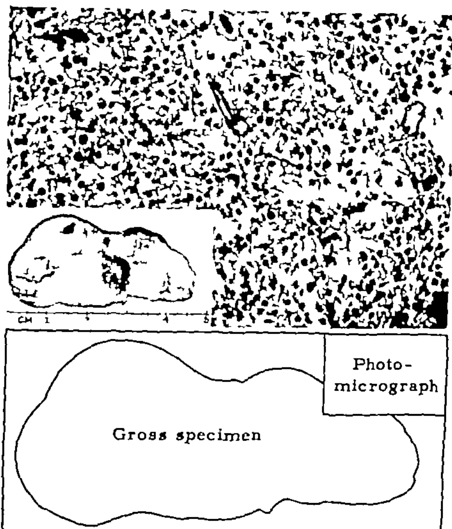


Fig. 10 Above Small gross specimen combined with its microscopic structure. *Below* The combination scheme and emphasis reversed

Roentgenograms

Roentgenograms submitted for publication should be positive prints. The opaque masses ought to appear as nearly white, and the less dense structures considerably darker (Figs 11 12)

Of all photographic prints, those from roentgenograms are the most likely to suffer in reproduction Differentiations evident enough in the films may really be too subtle to survive reduction through the engraving process.

If considerable reduction of roentgenograms is required for page accommodation the greater part of the reduction should be



Fig. 11 The use of arrows to indicate the margins of an area not well defined in the roentgenogram. (McCall and Wald.)

done by the photographer when he makes the prints. More detail is likely to be retained than when the entire reduction is incident to engraving. Also the author is better able to judge the probable value of a print if it approximates the size of its reproduction.

The value of roentgenograms may be increased under some circumstances by the addition of labels, arrows (Fig. 11) or other designations emphasizing the structure or area which the author desires to demonstrate. Line diagrams, used as inserts, are useful adjuncts (Fig. 12).

The retouching of photographs, x ray prints and photomicrographs to clarify details is considered permissible except in instances in which any modification would destroy the scientific value of the reproduction.

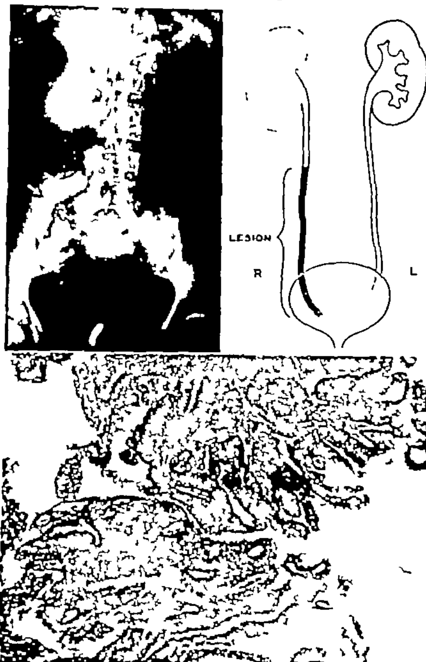


Fig. 12. Grouping arrangement of roentgenogram, with amplifying diagram, and photomicrograph from the same case. (Surgical Clinics of North America.)

Labels

Just as neat, legible labels add to the attractiveness of illustrations carelessly drawn and placed labels detract from what may

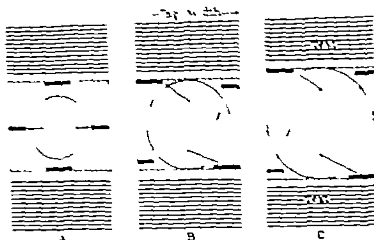


Fig. 13. Label placement. More often than not the width of the page or column is the criterion of necessary reduction and, therefore, the size of the picture when reduced may be directly affected by the placement of the labels (black). The overall linear dimensions (dotted outlines) of A and B are identical, although the actual picture (shaded area) in B is considerably the larger. In C the picture occupies the entire width of the type page at a slight sacrifice of text.

otherwise be admirable examples of art work. Labels should be part of the design of an illustration whenever possible. Properly spaced and distributed, such factors as symmetry and balance are maintained, and sometimes even attained. For this reason some illustrators lay out the labels so as to aid the general design. This is especially true when drawn illustrations are grouped together and an attractive page is the end in view.

A standard terminology for labels (including abbreviations) is preferred since the same illustrations are frequently used in different publications. To be entirely consistent, however, the terms used should correspond to those in the accompanying text. Such matters as consistent spelling, capitalization and punctuation should be reviewed. A misspelled word, discovered after the engraving is made, usually means the considerable extra expense of a new plate.

The use of symbol or key letters in place of spelled out labels should be avoided whenever possible. This type of designation is cumbersome and requires the reader to depend almost entirely on the legend and other context for orientation and identification of structures.

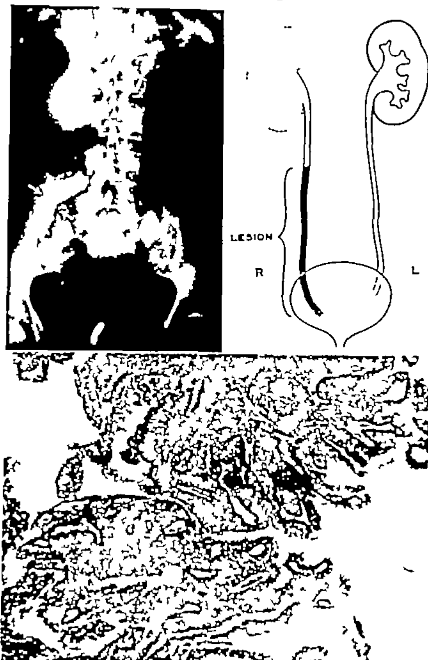


Fig. 12. Grouping arrangement of roentgenogram, with amplifying diagram, and photomicrograph from the same case (Surgical Clinics of North America.)

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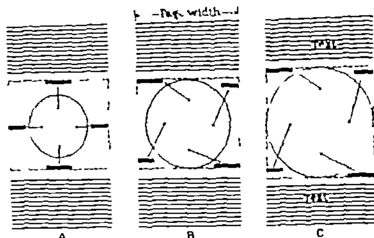


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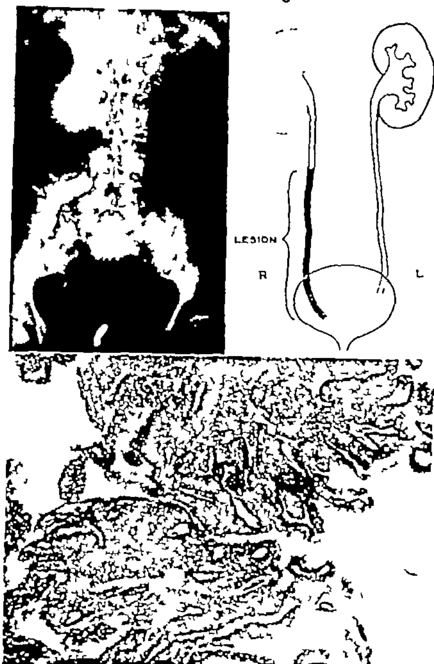


Fig. 12. Grouping arrangement of roentgenogram, with amplifying diagram, and photomicrograph from the same case (*Surgical Clinics of North America.*)

Labels

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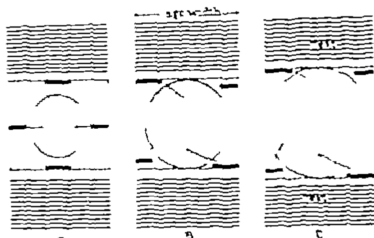


Fig. 13. Label placement. More often than not the width of the page or column is the criterion of necessary reduction and, therefore, the size of the picture when reduced can be directly affected by the placement of the labels (black). The overall linear dimensions (dotted outlines) of *A* and *B* are identical, although the actual picture (shaded area) in *B* is considerably the larger. In *C* the picture occupies the entire width of the type page at a slight sacrifice of text.

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A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n
o p q r s t u v w x y z

By airplane, New York is only a
short journey from Chicago-, ,?

A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n
o p q r s t u v w x y z

By airplane New York is only a
short journey from Chicago ; ,?

A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n
o p q r s t u v w x y z

By airplane New York is only a
short journey from Chicago-;,?

Fig. 14. Hand lettering by Lucille Cassell Innes in a simple style suitable for labels. *The middle and bottom groups are shown reduced one-third and one-half respectively*

Marginal labels, whether hand lettered set in type or pasted on necessarily increase the size of a picture and therefore may influence the cost of engraving and the degree of reduction (Fig. 13) Costs often may be lessened by placing labels and key letters

directly on the illustration, and by utilizing marginal indentations of the illustration within the over-all dimensions.

The style of letters used in labels should be simple. For hand-lettering (Fig. 14), a style somewhat similar to typescript is excellent and preferred by many illustrators. The product of the semi-mechanical lettering sets is satisfactory for nearly all purposes. However hand-lettering allows more flexibility in size and placement.

Letters reduced to less than 1 mm. in height are barely readable, even in line illustrations. One millimeter height in halftone reproductions is too small and therefore the calculation should be made when the original illustration is prepared.

At times it is advantageous to prepare the labels and leaders separately from the illustration. When this is done accurate register is assured if the labels and leaders are drawn on transparent material placed over the illustration. Separate preparation facilitates changes in leaders, labels and terminology if as may happen, changes are required by the publisher or author. Another advantage of the separate preparation is that when the combination engraving is made the labels and leaders will be unbroken by the screen used in making the ordinary halftone. The disadvantage of the method is the extra engraving expense.

Leaders or guide lines from labels to object should be of suitable thickness when reproduced for the eye to follow easily but not so pronounced as to subordinate the illustration proper. Continuity is best maintained by the use of black in light areas and white in light areas. Broken lines disturb the illustration less and are sometimes easier to follow than continuous lines. Heavy leaders tend to divide the illustration in an undesirable way.

Type, set for labels, is disadvantageous because of expense and some lack of flexibility of placement. If indented border spaces in halftone illustrations are to be utilized, outline cuts will be required. Partially justified (aligned on one side) type saves some of the expense of setting. In the case of halftone engravings, leader lines must be extended to the type by the engraver.

The Writing of Legends

Legends should be brief. Often the subject or title of an illustration is description enough. What should be said depends on the descriptive and identifying letters, labels and marks on the picture, and on the references to it in the text. The legends must be numbered in sequence to correspond with the figure numbers marked

on the illustrations, most publishers prefer to have them typewritten together on a separate sheet

Permissions to Publish

Courtesy demands that the author secure permission to republish an illustration belonging to another author or even one of his own which was originally reproduced by a different publisher If the illustration was published under copyright, and most illustrations are there is a legal obligation to obtain permission As a general thing, permissions should be requested by the author (rather than by the publisher) and it is best to do this well in advance of the date of expected republication Authors and publishers almost invariably grant permissions and willingly comply with requests to borrow a limited number of illustrations and sometimes engravings as well Publishers, however may be loath to lend engravings which they may need at any time and may offer to furnish electrotypes at a nominal cost instead

Written permissions from patients to publish their photographs should be obtained by the author whenever the photograph reveals the identity of the patient When the patient is a minor written permission should be obtained from the patient s parents or guardian as well. If the patient is dead, written permission should be obtained from the patient s surviving spouse, or if none, the closest relative, and in the case of a minor from the parents or guardian. But if the identity of the patient can be obliterated in the photograph in some way it is unnecessary to obtain permission to publish the picture Usually masking the face on the photograph by painting over the eyes on the negative or covering them on the print is sufficient to conceal identity but in rare instances some other means of rendering the patient unrecognizable must be devised

Copyrights

The rights of authors in their published illustrations are fully protected by the copyrights obtained by publishers upon application to the Section on Copyright Library of Congress

Miscellaneous Information

Illustrations which have been drawn on brittle chalk papers should be mounted on heavy pressboard and the surfaces of the pictures protected with cover flaps.

Soft crayon or any other medium that is easily smudged should be sprayed with a fixative to make certain that it will not be disturbed if touched

Insurance on a valuable shipment of illustrations is advisable.

Unless otherwise directed by the author publishers as a rule return illustrations to the source from which the illustrations were received. However the publishers must keep the illustrations on hand until after all the related editorial work has been completed.

Photoengraving

Photoengraving is a copying process with the inherent limitations of photography which, as such, is neither selective nor interpretive. The satisfactory result of photoengraving, therefore, depends entirely on the preparation of the illustration which will be copied.

Photoengravers are able to work at better advantage if they are spared the encumbrance of wide margins of paper surrounding the illustrations proper Wide mounts are bothersome

Line or Zinc Engravings

Pen and ink or line drawings are the simplest and cheapest to engrave and print and are usually welcomed by the publisher Line drawings reproduce faithfully if properly prepared. If they are sufficiently open as to spacing, reduction to a small size is possible without loss of detail. However the lines must be black and wide and strong enough to withstand proportionate loss by reduction lines too close together merge and print as solid black.

Various black and white technics are suitable for line engravings. Hand-stippling in black ink reproduces well. Lithographic crayon and drybrush (inked brush, partly "dry") on the special-surfaced papers are satisfactory methods when the reduction is not to be great. Drawings in lead pencil must be reproduced by the halftone process in most instances.

Ben Day patterns (named for the inventor Ben Day) applied by the engraver and various mechanical patterns which may be affixed by the illustrator are useful adjuncts to simple line drawings and charts and often serve admirably in place of color The mechanical patterns require no extra engraving cost, while Ben Day adds appreciably to this expense.

Line drawings may be combined with tone illustrations and etched for printing from a single plate. There are two methods,

combination plate and "double print which are described under Halftone Engravings.

Halftone Engravings

Halftone engraving is the process used to reproduce photographs roentgenograms and the various types of drawings in tone such as wash and brushed crayon As the term halftone implies, the reproduction is without tones of pure white or solid black The process differs from the line engraving in that the illustration is photographed through a ruled glass screen which breaks up the image into tiny dots. The varying size and density of the dots account for gradations of tone (Fig. 15) Because of these dots, an engraving made from a printed reproduction in halftone is unlikely to be wholly satisfactory

Square finish (Figs 6, 8 12) and *outline finish* are the two principal types of halftone engravings The former is used far more extensively because it is less costly Square finish is described as a halftone with an unbroken screen surface, finished in rec tangular shape with or without a border line" outline finish, as a halftone with the removal of all background surrounding or showing through or within the outline of an illustration.

Outline cuts emphasize the illustration because, when printed the illustration is surrounded by white paper However in case of marginal labels and leader lines on the illustration the routing away of the screen is not feasible and if a white background is wanted, an *outline combination plate* (Fig 16) is required With this method the illustration and the line work (labels etc) are photographed separately and the two film images recombined on one plate. The copper plate is then engraved at suitable depths for both halftone and solid black

Double print is also a combined line and halftone, although unlike combination plate, one film image is not necessarily imposed above the other the two may occupy separate portions on the plate. When superimposition is required the line and halftone illustrations are prepared separately usually the line part on a transparent overlay so that exact registration with the halftone is possible.

Illustrations in Color

Illustrations requiring color are so expensive to reproduce (see table page 62) that the publisher may feel obliged to ask the author to share the cost of publishing them



Fig. 15 Dot formation of a halftone engraving. The intermediate picture is reproduced in approximately the same size as the original photograph.

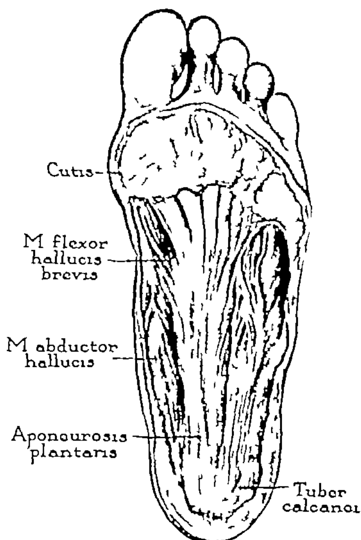


Fig. 16. Outline combination halftone reproduction from a transparent wash drawing by Mary Dixon. (By permission of Dr Barry J Anson)

Table of Engraving Costs Including the Proof Sheets (Philadelphia 1951)

" x 4	Line Engraving			$ 7 42
"	"	"	+ One Color Overlay	28 34
"	Halftone	"	Square Cut	9.87
"	"	"	Outline Cut	14 81
"	"	"	Combination Plate (average)	28 68
"	Full-Color Process Plates (color prints or paintings)			208 00
"	" " " "		(from Kodachrome film)	312.00

Full-color illustrations must be reproduced by the four-color process which entails heavy expense in all of the processes of

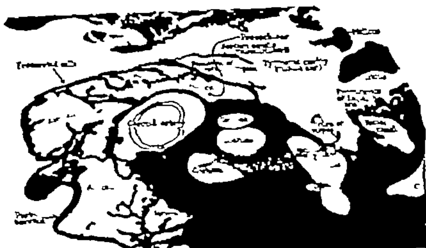


Fig. 17 Line engraving showing appropriate use of Ben Day patterns which were placed on the plate by the engraver The intermediate tones of gray provide excellent contrast and in this case were used instead of colors. The engraving cost would have been less and the same result obtained had similar patterns been placed on the original black and white drawing by the illustrator (By permission of Dr Barry J. Anson.)

publication and authors should not submit them without first consulting the publisher Before employing color in any form, the author and the illustrator should explore the possibilities of a black and white substitute. Ben-Day-type patterns (Fig. 17), mechan-

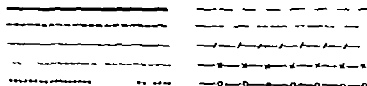


Fig. 18 Various types of lines, continuous and interrupted, which are useful in the preparation of charts and graphs. Lines in black, when well differentiated, will serve quite as well as would lines printed in colors.

ical or handmade, and varied lines (Fig. 18) will often indicate enough differentiation to serve in place of color Illustrations in

color including Kodachrome, in some instances retain illustrative value when they are reproduced as halftones.

The engraving cost only partly reflects the expense incident to the reproduction of color illustrations in books and periodicals, since such factors as printing, binding and location of the color pages are involved. The expense of a single reproduction in color might run to 100 times that of a line cut

IAPTER X. STATISTICS EMPLOYED IN MEDICAL PAPERS

It is hazardous to enter lightly into the preparation of a medical paper which presents clinical or laboratory data by means of figures—the statistical method. Yet this is done every day with perfect confidence, and the writer is frequently astonished by the fact that his results and conclusions are not accepted. The subject is complicated; there are several excellent books available (p. 93) and all that can be attempted here is to sketch a few problems to consider when writing a "statistical" paper and call attention to some of the common failings in medical articles which interfere with their effectiveness.

Aim in Using Statistics

What is the aim in using statistics as a means of presenting medical data? This has been defined by Yule as the use of "methods especially adapted to the elucidation of quantitative data affected by a multiplicity of causes." Put more concretely, suppose one were dealing with the problem of recovery from lobar pneumonia in which age, sex, state of nutrition, type of pneumococcus, geographic residence, and perhaps several other factors might be considered to have a possible influence on the outcome. It is in a study of this sort that the statistical method may be employed profitably, since the multiple variable factors can be summarized, analyzed, and described clearly by this means. If the basic studies are adequate the conclusions can be expressed more accurately by statistical means than in any other way.

The first problem, then, is to decide whether the clinical or laboratory data which are to be gathered for a particular study and paper can and should be treated by statistical methods. It is hoped that the subsequent discussions in this chapter may help the writer to reach this decision.

Collection of Data

Accuracy and Significance

The observations on which the statistical structure is built must be accurate or the paper will be like a *skyscraper resting on a* foundation of sand Reputable investigators never are consciously inaccurate but powers of observation are fallible and it is wise, therefore, to let some impartial observer in addition to the author go over the basic data This is a safeguard rather than a reflection on the powers of observation of the writer or on his integrity

A common problem particularly in clinical papers, is to *judge the possible significance of a statistical study in advance.* By this I do not mean significance in a statistical sense, which will be discussed later but rather whether conclusions drawn from the use of statistical methods will really mean much on the basis of the data collected If one were studying the effect of some drug on the duration of headaches for example it might be possible, even on a fairly large series to prove statistically that the drug shortened *the duration But in dealing with a disorder like this in which it is* usually most difficult to state exact times of onset and cessation—and entirely subjectively at that—the statistical proof" might not mean anything It is worthwhile, therefore, in planning a paper which will use statistics to consider early and in advance whether the figures, when they are obtained, can actually be used to draw conclusions which are really meaningful

Sampling

Any series of observations, whether made on guinea pigs *gastric juice, or patients is a sample of a whole* it is never possible to include *all* of the patients, gastric juices or guinea pigs in the world in any set of data. But the purpose of sampling is to enable the investigator to make deductions which can be generally applied *consequently the aim of this method should be to select* a sample which will be truly representative of the *whole* group e.g. all patients of a particular kind all gastric juices in peptic *ulcer all guinea pigs similarly constituted*

This purpose, and the need for a *representative* sample and not just any old collection of data, is too often overlooked Every sample is selected it is *how* this selection is made which determines whether or not the sample can be considered to shed light on a larger group Many of our hospital statistics are selected in such a way that the information they supply cannot be said to represent

larger groups most of the patients may come from a single economic level, the hospital may admit a high proportion of one sex or age group often individual judgment rather than chance determines the choice of treatment, and many other factors are likely to enter into the picture preventing the sample from being truly representative of the entire community

THE PROBLEM OF BIAS. The biggest problem in medical sampling is the introduction of bias. Since every sample is selected, the method of selection is often determined not only by the ease of getting data (perhaps from a source which is not representative), but also by the human factor of tending to select a sample which is likely to support the convictions of the author On this matter Pearl said

> If personal judgment, skills, or what is fancied to be wisdom are allowed to play any part in the choosing of individuals to go into the sample the result is practically certain to be biased. But if on the contrary some purely mechanical method of picking the individuals is rigorously and faithfully followed, without permitting judgments of what is good and wise to interfere with its operation, the sample is apt to be free of bias, provided the mechanical method was carefully planned in advance relative to randomicity

Consider how often the papers in the medical literature fail in this respect! Almost all follow up studies of the results of some particular operation are, for example, biased The patients operated on were self-selected in the first place because they presented themselves or were referred to the particular surgeon—surely not a random sample here. Then those who were operated on were separated from those who were not, usually because the surgeon expected better results in the former group But this again was selection on the basis of age, severity of the disease or some other factors. Finally the sample was influenced by the judgment and skill of the surgeon, the anesthetic, and which particular patients returned for the postoperative evaluation. Such studies may not be valueless, but it is clear that they do not fulfill the criteria outlined by Pearl and the results cannot therefore be extended to all patients. The *degree* to which application to larger groups is justified depends on the size of the sample, but is not applicable at all unless the sample is truly random.

QUESTIONNAIRES. One method of collecting samples which has become exceedingly common among clinicians is the use of questionnaires. This carries many dangers and the results require the most careful kind of interpretation. How are the individuals

selected to whom the questionnaires are sent? Are they chosen by some mechanical means which avoids bias? How is the questionnaire worded? Will the questions tend to produce more answers favorable to the preconceived ideas of the author or will it be equally easy to record unfavorable replies? And it is exceedingly rare for all questionnaires to be answered Which patients do not answer those who have died those who are dissatisfied those who are old or what are the reasons? In other words, the sample obtained is not even the *whole* sample and if the reasons for not replying in the missing group were known the conclusions might be quite different from those actually arrived at In general, therefore, the samples obtained *from questionnaires to patients are not* random samples and the results must be interpreted with caution

Comparability

In numerous papers involving statistical methods of handling clinical or laboratory data or vital statistics two or more characteristics are compared or matched It is wise to make sure that such characteristics are basically comparable and this involves critical examination of the meaning of the basic data before they are subjected to statistical calculations

In July 1935 the United States Bureau of the Census compiled a set of 1032 death certificates each recording from two to five causes of death together with other relevant information Eighteen countries were asked to classify these deaths according to selection principles then current. Wide differences in classification occurred one country allocated only 5 1 per cent of the deaths to respiratory *diseases whereas another classified 23 5 per cent in this category* although the two sets of death certificates were identical This situation has now been somewhat improved by wider use of the *International List of Causes of Death* but the results show how dangerous it is to compare international vital statistics

In spite of such knowledge, even professional statisticians are sometimes guilty of citing as evidence figures which are obviously not comparable The fact that the crude death rate is somewhat *lower in Australia and New Zealand than in the* United States has been advanced as a reason for turning to the medical care program of the former countries. But such figures are not comparable The age distribution of the populations are not alike the climate and diet are different Australia and New Zealand do not have the large Negro population of the United States (and it is well known that the life expectancy of the latter is lower than that of the white

inhabitants). Indeed, there are many other factors such as economic status and urban vs. rural residence all of which may play a part in differences between the crude death rates. Those who used this argument should have known better.

The same principles apply to clinical or laboratory data as to vital statistics. In the kind of study which lends itself to the use of controls, comparability can be obtained by selecting similar groups for comparison, e.g., experimental animals of equivalent age, sex, and weight; strictly alternate selection of patients for a new treatment (and even here the results will have to be scrutinized later for chance variations in factors like age which may affect the comparability of the groups).

The problem may be even more difficult. Take a hypothetical problem in which a new drug for peptic ulcer has become available and the investigator wishes to know whether to give up the method he has been previously following and switch all his patients to the new drug. He has two choices: either to treat a sufficiently large number of patients chosen by strict alternation by the old and new methods, or to place his new patients on the new medicine and compare the results with a similar group of patients he has treated in the past with the "old" method. The former is better but the latter is commonly employed. However, the investigator has to be careful that the two groups are really comparable. Are the economic conditions alike? Are the signs and symptoms equally severe in the two groups? Besides this one change in medicine have there been any other changes in the nature of the groups or in the management of the illness? All these things must be weighed before the groups can be considered comparable and any conclusion can be drawn as to the relative efficacy of the two drugs.

Analysis of Data

Having given some serious thought to the collection of a series of observations and finally being supplied with a set of figures, the author is next faced with arranging and analyzing his observations. The figures must be "significant" in the statistical sense so that the conclusions cannot be blown over like a house of cards by some reader who maintains that the results are meaningless because the writer has failed to analyze the figures properly. The analyses need to be carried farther for some studies than others, and of course the clinical or laboratory worker who has received a training in statistical methods is better off than most. But there are some elementary aspects of statistical analysis with which

every physician and investigator should be familiar and although employing certain methods will not guarantee that the writer s data will withstand criticism it will at least keep him from falling into the worst errors and give him an idea as to when it is necessary to call for expert help

Central Tendency—Average Median and Mode

The most common calculation presented in medical or biological reports is that of the arithmetic mean of a series of observa tions Among medical workers this is usually spoken of as the *average* professional statisticians employ the same method as one of several devices for determining the *central tendency* of the observed data The arithmetic mean or average is simple to calculate it is expressed as the sum or total of the individual observations divided by the number of observations A simple example which constantly recurs in medical papers is *age* In any study of patients it is almost routine to record ages and express the average of all of those observed. Suppose that 20 patients were involved ranging in age from 13 to 78 years. By adding all the ages and dividing by 20 the *average* age may be found to be 54 years as shown in the following section

Usually the average is the most desirable method of expressing the central point or tendency in a series but sometimes the *median* is calculated which is that number exactly dividing the observations so that an equal number fall above and below that figure. The *mode* is another measure of central tendency It is that number which occurs among the observed figures more often than any other

Variability—Standard Deviation

The individual observations of a series will not all be alike in the vast majority of instances. Variability exists in all types of observations whether they be levels of hydrochloric acid in the gastric juice, weights of rats, or leucocyte counts For this reason several statistical measures have been devised for expressing the degree of scatter or variation from the mean Of these, the *standard deviation* is one of the most useful and is therefore usually applied by the statistician It is a method of calculating and express ing how far individual observations diverge from the average—either above or below Consequently a small standard deviation shows that most of the observations are clustered fairly closely around the arithmetic mean, whereas a large standard deviation

indicates that there is a wide gap between the average and many of the individual observations.

Without going into the mathematical background a simple way to express the standard deviation is as follows

$$\sqrt{\frac{\text{sum of squares of deviations from mean}}{\text{total number of observations}}}$$

This is a measure of the scatter or variation from the mean. Take the age situation in the hypothetical report mentioned under the preceding section

INDIVIDUAL AGES	DEVIATION FROM MEAN	SQUARE OF DEVIATION
42	−12	144
28	−26	676
63	+9	81
64	+10	100
13	−41	1681
78	+24	576
58	+4	16
65	+11	121
64	+10	100
35	−19	361
52	−2	4
60	+6	36
69	+15	225
57	+3	9
59	+5	25
48	−6	36
68	+14	196
71	+17	289
55	+1	1
31	−23	529
		5206

$$\text{Standard deviation} = \sqrt{\frac{5206}{20}}$$
$$= \sqrt{260.3}$$
$$= 16.1$$

What conclusions can be drawn from this application of the standard deviation? First, *it is a large deviation* and therefore shows that the individual ages varied rather far from the average of 54. Second, only one of the cases fell in an age lying outside the two standard deviations on either side of the mean (21.8 to 86.2 years) which statisticians might consider significant; therefore in this particular hypothetical study age seems to have little or no

significance in regard to any other attribute which might be the subject of this study

There are two principal aspects of standard deviation the calculation and the interpretation. In small series, such as the one just presented and the one following, it is laborious though not too difficult to arrive at the mean list the deviations from the mean, and square the latter with pencil and paper, in large series, which are less common in clinical and laboratory studies a slide rule is almost essential. One reason for squaring the deviations is to eliminate the minus signs The interpretation depends on the nature of the study as well as on the absolute figure of standard deviation arrived at For example the following hypothetical study deals with a single type of measurement on two small groups for which a comparison is desired

Weights of 20 Boys and 20 Girls Aged 14

	WT OF BOYS (LB.)	DEVIATION FROM MEAN	SQUARE	WT OF GIRLS (LB)	DEVIATION FROM MEAN	SQUARE
	95	−11	121	104	−12	144
	108	+2	4	116	0	—
	104	−2	4	99	−17	289
	112	+6	36	119	+3	9
	92	−14	196	121	+5	25
	98	−8	64	126	+10	100
	121	+15	225	109	−7	49
	132	+26	676	133	+17	289
	88	−18	324	111	−5	25
	109	+3	9	108	−8	64
	116	+10	100	112	−4	16
	105	−1	1	114	−2	4
	100	−6	36	123	+7	49
	118	+12	144	122	+6	36
	99	−7	49	103	−13	169
	119	+13	169	117	+1	1
	90	−16	256	121	+5	25
	103	−3	9	128	+12	144
	107	+1	1	115	−1	1
	104	−2	4	119	+3	9
TOTALS	2120		2428	2320		1448

Mean (boys) 106 Mean (girls) 116

Standard deviation (boys) $= \sqrt{\frac{2428}{20}} = \sqrt{121.4} = 11$

Standard deviation (girls) $= \sqrt{\frac{1448}{20}} = \sqrt{72.4} = 8.5$

From these data and calculations several deductions would be possible, *assuming* that the samples are random and truly representative of the whole group (1) the mean or average weight of boys at the age of fourteen is less than that of girls of the same age and (2) the weight of the boys tends to vary more widely from the mean than that of girls as shown by the larger standard deviation of the former The comparison between the means and standard deviations would *not* prove that boys are less healthy than girls at this age because they weighed less and some boys are farther away from the *average* than girls the average may not in either instance be the ideal weight for good health. In other words one must be cautious in drawing unwarranted conclusions from this or any other statistical calculation.

Coefficient of Variation

In order to compare the variabilities of different frequency distributions another measure for this purpose has been devised termed the *coefficient of variation*. This is expressed in percentages as

$$\text{Coefficient of variation} = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

Thus in the example of ages previously cited the coefficient of variation would be calculated as follows

$$\text{Coefficient of variation} = \frac{16.1}{54} \times 100 = 29.8 \text{ per cent}$$

If the mean average age had been 25 instead of 54 and the standard deviation the same the coefficient would have been different

$$\frac{16.1}{25} \times 100 = 64.4 \text{ per cent}$$

A high percentage for the coefficient of variation indicates that a large number of the individual observations are a long way from the arithmetic average.

In this calculation the original unit of measurement is canceled and becomes unimportant because it is present in both numerator and denominator This makes comparisons involving different units of measure possible.

From this cursory discussion it should be clear that it is dangerous to think of averages or means as presenting a complete picture, and that unless one thinks of variation and frequency

distributions and makes the necessary calculations the writer's conclusions will often be fallacious

Probability and Chance—Chi Square Test

In all samples—and statistics always deals with samples—there is a possibility that the results observed or collected are due to chance and therefore are not significant. For this reason it is necessary to study the figures to determine whether the results are significant or not In other words it must be decided for any given set of observations whether it is *probable* that they arose through chance alone and are valueless for drawing conclusions or whether it is *probable* that they could not have arisen by chance and therefore are significant.

The statisticians have developed several methods of weighing the probabilities by mathematical means In complex problems it is often advisable to use more than one of these methods One of them is the *chi square test* originally devised by Professor Karl Pearson and considered to be particularly useful in the handling of the usual kinds of medical and biological data.

The chi square test is especially valuable in comparing the characteristics of two or more groups. The question at issue is whether the differences between such groups are more than would exist by chance *if the differences are considerably more than might* be expected it is probable that there is a relationship The chi square test partially answers this question it is not absolute and its value depends in part on the number of groups as well as on the figure produced by its calculation Furthermore, it is valid only for frequencies and not for ratios, and it does not supply information on the *meaning* of any possible associations or differences

There are many complex mathematical aspects of this test but it can be applied as simple arithmetic to many laboratory or clinical problems and thus is useful to the medical writer in determining the element of chance in his observations Without going into great detail I can think of no better way of discussing this valuable test than by illustrating its use in a hypothetical problem

Suppose the question is to determine whether left handedness in the mother has anything to do with left handedness in the offspring. The first step is to obtain a random sample of children record which hand each child uses and then inquire concerning left and right handedness in the mothers of those children The hypothetical results may be expressed as

	RIGHT-HANDED MOTHER	LEFT-HANDED MOTHER
Left-handed children	8 (a)	10 (b)
Right-handed children	152 (c)	30 (d)

At first glance it appears that a high proportion of left-handed children have left-handed mothers and that left handedness in the mother almost certainly has some influence on whether a child will be right or left-handed. But this may or may not be true from the figures given, since there is no information supplied on how much of the *apparent* difference may be due to chance. This is where the chi square test comes in.

The first step is to calculate the number which might be expected in each group on the basis of the group as a whole. This theoretical or expected frequency is arrived at by the following formula, the mathematical background for which it is not here necessary to explore

> A is the expected number in (a) shown in the tabulation
> B is the expected number in (b) shown in the tabulation
> C is the expected number in (c) shown in the tabulation
> D is the expected number in (d) shown in the tabulation
> N is the total number of observations in this instance 200

The calculation of the expected figures is thus obtained as follows

$$A = \frac{(a+b)}{N} \times \frac{(a+c)}{N} \times N = \frac{8+10}{200} \times \frac{8+152}{200} \times 200 = 14.4$$

$$B = \frac{(b+a)}{N} \times \frac{(b+d)}{N} \times N = \frac{10+8}{200} \times \frac{10+30}{200} \times 200 = 3.6$$

$$C = \frac{(c+a)}{N} \times \frac{(c+d)}{N} \times N = \frac{152+8}{200} \times \frac{152+30}{200} \times 200 = 145.6$$

$$D = \frac{(d+b)}{N} \times \frac{(d+c)}{N} \times N = \frac{30+10}{200} \times \frac{30+152}{200} \times 200 = 36.4$$

The following table of theoretically expected frequencies is thus arrived at

	RIGHT-HANDED MOTHER	LEFT-HANDED MOTHER
Left-handed children	14.4 (A)	3.6 (B)
Right-handed children	145.6 (C)	36.4 (D)

The formula for chi square can now be applied

$$\chi = \frac{(A-a)^2}{A} + \frac{(B-b)^2}{B} + \frac{(C-c)^2}{C} + \frac{(D-d)^2}{D}$$

Using the figures available chi square works out

$$\chi^2 = \frac{(14.4-8)^2}{14.4} + \frac{(3.6-10)^2}{3.6} + \frac{(145.6-152)^2}{145.6} + \frac{(36.4-30)^2}{36.4}$$

$$= 15.6$$

How is this then interpreted? It depends on a complex mathematical foundation, including the number of degrees of freedom (in this instance only one) as well as on the value of chi square itself. But there are tables which help at this point (Appendix, p. 103). From the table it may be observed that for a chi square of over 15 and a number of degrees of freedom of one (n) the P or probability is less than 0.01 which means that there is less than 1 chance in 100 that the figures could be the result of chance. In this instance, therefore, the initial impression concerning the relationship between left handedness in mother and child may be considered statistically significant as judged by this test. It does not *prove* the connection or how it may act; it merely shows that the figures obtained have only a slight possibility of being the result of chance.

Another hypothetical example may be presented to show a different type of problem in which the chi square test is applied to a larger number of subgroups.

The question is which of five preparations is of more value in the treatment of pneumonia. It must be assumed that the patients in each subgroup are random and representative samples and the chi square test is applied to determine whether the differences in results are probably due to chance or are likely to be significant.

The basic information (hypothetical) may be expressed as

Results of Treating Patients with Pneumonia

DRUG USED	NO. OF PATIENTS	RECOVERED	(EXPECTED)	DIED	(EXPECTED)
Sulfadiazine	102	89 (a)	86.9 (A)	13	15.1
Aureomycin	83	67 (b)	70.7 (B)	16	12.3
Penicillin	115	103 (c)	98.0 (C)	12	17.0
Chloramphenicol	48	33 (d)	40.9 (D)	15	7.1
Terramycin	65	60 (e)	55.4 (E)	5	9.6

It will be noted that 413 patients were involved in the study, of which number 85.2 per cent recovered. The expected values shown in the table are reached by applying this percentage to the patients in each subgroup.

$$\chi^2 = \frac{(A-a)^2}{A} + \frac{(B-b)^2}{B} + \frac{(C-c)^2}{C} + \frac{(D-d)^2}{D} + \frac{(E-e)^2}{E}$$

$$= \frac{(86.9-89)^2}{86.9} + \frac{(70.7-67)^2}{70.7} + \frac{(98-103)^2}{98} + \frac{(40.9-33)^2}{40.9} + \frac{(55.4-60)^2}{55.4}$$

$$= \frac{1^2}{86.9} + \frac{3.7^2}{70.7} + \frac{5^2}{98} + \frac{7.9^2}{40.9} + \frac{4.6^2}{55.4}$$

$$= 0.05 + 0.19 + 0.26 + 1.53 + 0.38$$

$$= 2.41$$

Turning to the χ^2 table (Appendix, p. 103) it is found that a chi square of 2.41 with an n (number of degrees of freedom) of 4 gives a P greater than 0.50 (actually about 0.70), which means that there are about seven chances in ten that any differences between the results with the different preparations were due to chance. Under these circumstances it would be hazardous to conclude that one preparation was superior to another assuming that the patients were alike in relevant respects except for the drug used.

The chi square test can be applied to a larger number of subgroups or samples by the same formula, but the arithmetic becomes increasingly lengthy and the aid of a slide rule or a statistically trained colleague may be needed for the more complex applications of this important tool for testing for significance.

Coefficient of Correlation

Many of the statistical devices are aimed essentially at determining whether the sampling of observed data may be significant. One of the most important of these, especially when dealing with the construction of curves, is the correlation coefficient. This is one way to measure the *degree* of relationship between two or more characteristics, as for example, left handedness in the mother and that in the child. It measures this one characteristic only and *cannot* be interpreted as indicating any cause and effect between the characteristics, no matter how close a *relationship* is revealed.

Again, the easiest way to show how the correlation coefficient may be used is to illustrate with a small sample (it may be used for large samples also) and follow the steps of the calculation, omitting the mathematical background and using simple terms instead of the symbols commonly employed in mathematical formulas. The example presented is a series of hypothetical observations on basal metabolic rates and weights the question is whether weight

Using the figures available chi square works out

$$\chi^2 = \frac{(14\ 4-8)^2}{14\ 4} + \frac{(3\ 6-10)^2}{3\ 6} + \frac{(145\ 6-152)^2}{145\ 6} + \frac{(36\ 4-30)^2}{36\ 4}$$

$$= 15\ 6$$

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$$= \frac{2.1^2}{86.9} + \frac{3.7^2}{70.7} + \frac{5^2}{98} + \frac{7.9^2}{40.9} + \frac{4.6^2}{55.4}$$

$$= 0.05 + 0.19 + 0.26 + 1.53 + 0.38$$

$$= 2.41$$

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Again, the easiest way to show how the correlation coefficient may be used is to illustrate with a small sample (it may be used for large samples also), and follow the steps of the calculation, omitting the mathematical background and using simple terms instead of the symbols commonly employed in mathematical formulas. The example presented is a series of hypothetical observations on basal metabolic rates and weights the question is whether weight

and metabolism are correlated or not and the method employed is the correlation coefficient The hypothetical data may be expressed as

CASE	BASAL METABOLIC RATE	DEVIATION FROM MEAN	WEIGHT	DEVIATION FROM MEAN
1	+5	+1 6	116	−5 3
2	−15	−18 4	130	+8 7
3	−22	−25 4	145	+23 7
4	+30	+26 6	110	−11 3
5	+16	+12 6	105	−16 3
6	−25	−28 4	150	+28 7
7	−10	−13 4	140	+18 7
8	+28	+24 6	111	−10 3
9	+9	+5 6	98	−23 3
10	+18	+14 6	108	−13 3
	Mean +3 4		Mean 121 3	

At first glance it would seem that the patients with low metabolism tended to weigh more, while those with high metabolic rates tended to weigh less. But are the basal metabolism and weight really correlated? The first calculation is to find the mean or average metabolic rate and the mean of the weights These come to +3 4 and 121 3 respectively The next step is to record the difference between each individual observation and the mean This is shown in the table under the columns labeled "deviation from mean For each case, multiply the deviations from the mean for basal metabolic rate by the deviation from the mean for weight taking account of plus or minus signs The sum of the products is added, giving in this example a figure of − 2920 20 The *mean product* is found by dividing this total by the number of observations (N) less one here there were ten observations so that the divisor would be 9 giving a mean product of − 324 47 (For large samples, it is proper to use *N* or the whole number of observations in the standard deviation but for small samples *N* − *1* is correct In either case the same number must be used in the mean product in the denominator of the formula for the correlation coefficient as is used in the standard deviation)

The next step is to calculate the standard deviations for the basal metabolic rates and for the weights, using the method described on page 71 but the divisors used in each instance (this being *a small sample*) are one less than the number of cases, in this instance 9 This calculation gives standard deviations of 20 2

for the metabolic rates and 18.4 for the weights. Now the figures are available to calculate the correlation coefficient which may be expressed as

$$\text{Correlation coefficient} = \frac{\text{Mean product of deviations}}{\text{Product of standard deviations}}$$

Substituting the figures previously obtained, we have

$$\text{Correlation coefficient} = \frac{-374.47}{20.2 \times 18.4} = \frac{-374.47}{371.68} = -.67$$

How is this to be interpreted? The coefficient may vary from +1 to −1: the closer it approaches to either +1 or −1 the greater the degree of correlation. Consequently the closer it is to 0 the less likelihood there is that the relation between the characteristics involved is significant. In the instance given the correlation coefficient is close to −1 and it is therefore probable that the metabolism and weight are significantly related. However, this would merely indicate the *probability* that the levels of weight and of basal metabolism were correlated and would cast no light whatever on the question of whether a high basal metabolic rate reduces the weight or vice versa.

Common Pitfalls

The medical writer is concerned with attempting to prove that the data which he has collected mean something and he uses statistics as a tool to support his case. Statistics actually do *not prove* anything, but when properly employed they may support the writer's contention that there actually is an association between the events observed. Even when applying statistical tools, however, the medical writer must be on the alert to avoid a number of traps which may lead him toward conclusions which are entirely unwarranted.

FALLACIOUS COMPARISONS. The greatest of the pitfalls is noncomparability of the records. It is fallacious, for example, to compare the frequency of a particular disease in men as opposed to women unless the figures are corrected not only for the *expected* incidence in the two sexes, but also for the number of each included in the sample. A simple example would be to find that a police docket contained the names of 300 men and 50 women who were involved in traffic accidents and to conclude that men were therefore six times as liable to have such accidents as women. The only way to answer the implied question would be to obtain figures on

the relative number of men and women drivers and to determine their risk to accident by the average number of miles driven in a specified time by each sex. Suppose then that only half as many women drive as men and that in an average month the men drivers were each at the wheel 1000 miles whereas the average woman drove 250 miles. By simple arithmetic it can therefore be shown that men by their greater driving, are *exposed* to traffic accidents eight times as much (on the average) as women One would then conclude not that men were six times as prone to traffic accidents as women but that on the *basis of exposure to risk* of accident women had one and one-third times the liability to accidents that men had! This question of exposure to risk arises with great frequency in medical studies and must always be considered when comparison between different groups is made

The most remarkable example of figures don t mean what they seem that I know of was given in the form of an examination question to which I was exposed years ago The question went something like this How would you explain a *decrease* in the death rate of New York City and a *decrease* in that of New York state outside of the city but an *increase* in the death rate for the state as a whole?' Most of my friends on whom I have tried this say it is impossible. But here are figures showing how it can occur

	1920			*1930*		
	POPULATION	DEATHS	DEATH RATE PER 1000	POPULATION	DEATHS	DEATH RATE PER 1000
New York *City alone*	2,000,000	50,000	25	6,000 000	140,000	23 33
New York State excl.	2,000,000	25 000	12 5	3 000 000	35 000	11 66
State as whole	4 000,000	75,000	18 75	9 000 000	175 000	19 44

The point illustrated by this example is common in medical problems There are in the example *two* variables, the size of the populations at risk and the attack rates, both of which may vary Thus the time element becomes of great importance and must be taken into account in making the interpretations

It would be possible to continue almost indefinitely with hypothetical and actual examples of fallacious comparisons One more only will be mentioned here because examples of its kind are hard to avoid unless the medical writer is consciously on the look

out. This is the question of *attributes* two series of observations are compared in order perhaps, to decide between the efficacy of two kinds of treatment for cancer of the lip If one series, however contains a different percentage of far advanced cases than the other it is not reasonable to draw any conclusions concerning therapy since the attributes of the two are not alike. This is the same kind of problem previously alluded to in discussing evaluation of clinical results by such terms as good, fair or excellent, which are so likely to differ from observer to observer or by international comparisons of deaths when the classifications in different countries are not alike Any attempts at comparisons will prove futile unless the groups compared have like attributes.

PERCENTAGES. Percentages are merely a means of expressing the results of a study involving a number of patients or observations. There appears to be no absolute rule as to when percentages should or should not be used, but an expert in statistics advised me some years ago that in his opinion percentages should not be employed when fewer than 100 observations were involved. The reason for this is twofold that percentages are unnecessary for a small number of observations because it is just as easy for the reader to interpret the basic figures, and that they give a false impression of reliability If one is referring to 20 patients, 2 of whom died, it is just as clear to the reader to say that 2 of 20 patients died, as it is that 10 per cent of the patients died It is essentially more precise also among the next 20 patients observed 6 might have died. If this had occurred, the death rate would have been 30 per cent instead of 10—a result which would have given an entirely different picture to the reader For these reasons it seems good policy not to employ percentages except when the number of observations or patients has exceeded 100 thus giving a large enough number to warrant this mode of expression.

A few years ago Campbell pointed out another frequent failing in the use of percentages. He illustrated it this way In a series of patients with delayed operation, the mortality was 1.5 per cent, whereas in the series with immediate operation, the mortality was 4.8 per cent. From this it may be concluded that death occurs more than three times as frequently after immediate operation. Now this is a common error Campbell says, which is brought about by the self-delusion of the writer In this case the figure 4.8 had been taken and the conclusion drawn that it is more than three times 1.5 which of course is true However it should have been pointed out that regardless of whether the operation was delayed or

immediate the *recovery* rate was 98 5 and 95 2 per cent respectively a difference of only 3 3 per cent which gives an entirely different impression than the conclusion originally expressed

Presentation of Statistical Data

The final problem in preparing statistical data for publication is the decision on how the material is to be presented Unless this question is properly answered the reader *may not accept the* writer s observations and conclusions as completely as would be the case otherwise. Tables and graphic representations constitute *the principal methods used Their proper application is an art in* itself and only a few of the high spots can be touched on here

Tables

The purpose of tables is to express the nature of the relation ship between certain observed phenomena in such a manner that the reader can understand the data and conclusions clearly Pearl has said The purpose of tabulation is to so arrange observations that like cases shall be put together and their frequency of occur rence in the whole group thus be made apparent

Unfortunately many medical writers do not seem to have *the aim of tabulation clearly in mind Many published tables are* merely lists of individual observations One such which I saw not long ago consisted of a list of cases of a particular disease recorded over a four year period it occupied twelve full pages in the medical journal in which it was published. In this table no effort had been made to put the 64 cases together in such a manner that the reader could draw any deductions concerning average age, duration of symptoms or any other common features. Yet to do this is the purpose of tabulation

Before constructing a table it is well to ask oneself first what its *purpose* is to be and what it is supposed to accomplish in the *mind of the reader After the table has been prepared the writer may* again ask himself how well the table has served these objectives Pearl who made these suggestions, recommends that the writer who wishes to gain *skill in the construction of tables might well* apply these questions to each table which he sees in print

After deciding the aim of the proposed table, the data must be sorted into groups of like characteristics. The *degree* of likeness depends on the purpose of the table it might for example consist of *all* patients with leprosy if the study involved gallstones the grouping of like with like might require subdivisions classified by

age and sex. In other words, the decision as to what characteristics to consider as "like" depends on what is to be demonstrated in the table.

There are a few *general principles* to which every table should conform

1 The table should be clearly intelligible by itself without reference to the text. This means that it must have a title which fully states the subject and describes the material presented. Each column must be completely labeled. It is not sufficient, for example, to head a column "Height" without including information on whether it is in inches, meters, or whatever the *unit* of measure happens to be.

2. The actual *number* of observations should always be indicated, since the listing of proportions or rates alone may give an entirely false picture and without the basic figures the reader is deprived of vital information.

3 When rates are given in a table the *base* must be clearly stated it makes a lot of difference whether a fatality rate is 50 per thousand or per hundred thousand!

4 Tabulation of averages or means alone is inadvisable if it can be avoided frequency distribution gives a better picture of the data.

5 Finally a table should include information on what is left out, and the reasons for the omissions. If a follow-up study for example, omits a large number of patients who have died thus exerting a potentially tremendous influence on the results, the reader is entitled to know about it.

There are many excellent scientific workers who in reporting their investigations, fail to follow these basic principles. The example shown in Fig. 19 is the first half of a table in which the author has summarized his observations, but has not fully analyzed the table's purpose or the effect it will produce on the reader It is difficult to tell from the table alone just what the author considers really important, or what the data prove or disprove.

The table shown in Fig. 20 is better The subject is adequately stated and the purpose is clear The number of cases in each group is stated, and the reader encounters no difficulty in knowing what the writer wants him to see and to conclude. But even this could be improved somewhat. The percentage column under "Relapses" could be omitted entirely the one figure appearing in that column not only gives an impression of false reliability considering the number of observations involved but adds nothing which "7 out of

Hematologic Data in 34 Cases of Multiple Myeloma

First horizontal column in each case signifies blood count when first seen second column after therapy had been completed. (This period of time does not necessarily correspond to the duration of treatment as noted in Table 3 The time elapsed between blood counts here is actually the time from the first blood count to the final significant blood count after therapy had been completed and had had time *to become effective.*)

CASE NO	ELAPSED TIME (months)	HEMOGLOBIN (grams %)	RBC × 10⁶/MM.³	WBC × 10³/MM.³	PLATELETS × 10³/MM.³	POLYS	LYMPHOCYTES %	MONOCYTES	PLASMA
1	0	10.2	3.36	7.05	240	86	5	9	
	1.5	7.5	2.36		190				
2	0	12.4	4 41	6.35	89	56	31	13	
	12	12.5	2.98	2.65		57	47	1	
3	0	13 4	4.39	6.7		43	54	3	
	6	anemia							
4	0	14.2	4.32	9.2		45	53	2	
	80	10.2	3 85	11 75		63	31	6	
5	0	8.5	2.75	4.0	160	68	26	5	1
	4.5	7.8	2.39	4.2	45	68	23	7	2
6	0	7 6	2.52	6.4	220	66	30	4	
	2	10.0	3 77	8 9		78	18	4	
7	0	9 9	3 1	10.4		72	22	6	
	7	5 4	1 74	1.6	18	64	33	3	
8	0	12.2	3 65	5.8	310	73	15	12	
	1.5	10 4	3 11	7 0	95	66	30	4	
9	0	16.9	5 6	15 0	365	71	29		
	9.5	9.3	.95	7 45	120	86	11	3	
10	0	9.0	3 6	7 45	115	64	26	10	
	5	5.9	2.14	4 4	275	66	30	4	

Fig. 19 Example of a table which fails to analyze its purpose and thus is not clearly intelligible by itself

13 patients does not supply at a glance Also the word affected in the left hand column under Relapses could be omitted Nevertheless this table compares favorably with most of those which appear in the medical literature.

There are some practical if minor points in the construction of tables which deserve attention One is the *size* of the table. If too

Relation of Relapses of Typhoid Fever to Duration of Chloramphenicol Treatment

PATIENTS		TREATMENT WITH CHLORAMPHENICOL					RELAPSES	
		Duration of Treatment		Administration				
				Day of Disease				
Group	Number	General Period	Total Days (average)	Started (average)	Stopped (average)	Total Grams Given (average)	Number of Patients Affected	Per cent of Patients Affected
A	13	8 days or less	6.9	13.5	20.4	20.0	7	53.8
B	19	9 to 14 days	11.2	13.7	4.9	[illegible]5.7	0	0
C	12	Longer than 14 days	18.0	20.8	38.8	32.8	0	0

Fig. 20. A good table.

much material is included in a single table the data may be hard for the reader to comprehend. Furthermore, in reproducing such a table for publication the type may need to be reduced so greatly in order to make the table fit the page, that it becomes practically illegible. It is, therefore, important to anticipate the final appearance and perhaps to use two or more tables in some instances when only one was originally contemplated. Finally it is helpful to the reader if the type can all be read horizontally it is annoying to be required to turn a whole journal or book in order to read the column headings such as those shown in Fig. 21

Results of Tests of the Blood in a Patient with Lipomelanic Reticulosis

DAY	HEMOGLOBIN*	RED BLOOD CELLS	COLOR INDEX	WHITE BLOOD CELLS	POLYMORPHONUCLEAR CELLS†	LYMPHOCYTES†	MONOCYTES†	EOSINOPHILS†	BASOPHILS†	PLATELETS
1 31 40	100	5,200,000	1	7,800	67	18	8	7		
3 9 40	91	5,970,000	0.92	9,400	52	23	9	11	2	Normal
5 ?7 40	85	4,130,000	1.11	15,250	36.5	[illegible]1.5	7.5	33	1.5	Normal
6 ?7 40	81	4,420,000	0.98	11,[illegible]50	31.5	[illegible]4	15.5	31.5	1.5	Normal

Fig. 21 The perpendicular column heads in this table are annoying to the reader

* Grams per hundred cubic centimeters. † Percentage.

Hematologic Data in 24 Cases of Multiple Myeloma

First horizontal column in each case signifies blood count when first seen second column after therapy had been completed. (This period of time does not necessarily correspond to the duration of treatment as noted in Table 3 The time elapsed between blood counts here is actually the time from the first blood count to the final significant blood count after therapy had been completed and had had time to become effective.)

CASE NO.	ELAPSED TIME (months)	HEMOGLOBIN (grams %)	RBC × 10^4/mm.^{3}	WBC × 10^3/mm.^{3}	PLATELETS × 10^3/mm.^{3}	POLY SERIES %	LYMPHOCYTES	MONOCYTES	PLASMA
1	0	10.2	3.36	7.05	240	86	5	9	
	1.5	7.5	2.36		190				
2	0	12.4	4 41	6.35	89	56	31	13	
	12	12.5	2.98	2.65		57	42	1	
3	0	13 4	4.39	6.7		43	54	3	
	6	anemia							
4	0	14.2	4.32	9.2		45	53	2	
	80	10.2	3.85	11 75		63	31	6	
5	0	8.5	2.75	4 0	160	68	[illegible]6	5	1
	4.5	7 8	2.39	4.2	45	68	23	7	[illegible]
6	0	7 6	2.52	6.4	220	66	30	4	
	2	10.0	3 77	8.9		78	18	4	
7	0	9 9	3 1	10.4		72	22	6	
	7	5 4	1 74	1 6	18	64	33	3	
8	0	12.2	3.65	5.8	310	73	15	12	
	1.5	10 4	3 11	7.0	95	66	30	4	
9	0	16.9	5 6	15.0	365	71	29		
	9.5	9.3	2.95	7 45	120	86	11	3	
10	0	9 0	3 6	7 45	115	64	26	10	
	5	5 9	2.14	4 4	275	66	30	4	

Fig. 19 Example of a table which fails to analyze its purpose and thus is not clearly intelligible by itself

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There are some practical if minor points in the construction of tables which deserve attention One is the si e of the table If too

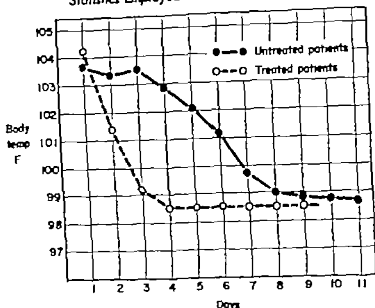


Fig. 22. Averages of body temperature in 75 untreated patients with lobar pneumonia and 80 treated with penicillin.

reasonably the significance of the material presented. A series of hypothetical data has been drawn on three different scales in Fig. 23 It should be noted that the different effects are created by changing the scales of the ordinates and abscissas. In addition to choosing a scale which will best reflect the nature of the study the writer has to decide which characteristic to plot on the ordinate and which on the abscissa sometimes this makes a great deal of difference.

Bar Diagrams. Bar diagrams are also commonly used in presenting medical data. They serve a useful function, particularly for impermanent phenomena such as nausea or jaundice in contrast to body temperature or pulse rate for which continuous lines can be drawn. When properly constructed (scale is important in bar diagrams also) and if adequately labeled, they are easy on the eyes, readily interpreted and particularly useful in lantern slides. Figure 24 shows two typical examples.

Pie Diagrams. Another common form of graphic presentation is the pie diagram. This form of graph is used to show the propor tions which separate characteristics have to the whole. It is popular in public health education and is used extensively in governmental

The presentation of observed data by tables is not simple and deserves more effort than it commonly receives But adequate tabulation is extremely important and skill in constructing tables *may be acquired by analyzing their purpose and by practice.*

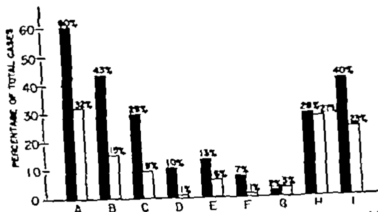
Graphic Presentation

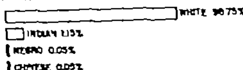
Awareness of the uses and limitations of charts and curves and of the different kinds which can be employed to serve particular needs can be highly useful in the preparation of medical articles The purpose of all graphic *representations is merely to organize* statistical observations in a manner which can be comprehended *visually* and thus aid the reader to understand the *meaning* of the figures more readily Examination of the medical literature reveals that this objective is often not appreciated and many graphic presentations fail to make the reader's task easier Sometimes, indeed they give an erroneous impression of the meaning of the computations.

Statistical diagrams are constructed by setting up a system of coordinates after which *points lines, or surfaces can be inserted* connected, or blocked out to provide the visual picture. The graphic presentation cannot be considered as a substitute for the statistical data but only as a means of making such material more *comprehensible hence the writer who wishes to employ this device* can choose which of several graphic methods is best suited to his data and to the audience at which he aims.

RECTANGULAR DIAGRAMS In medicine the most common form of diagram is the rectangular in which one characteristic is plotted along the horizontal coordinate and another along the vertical coordinate The example shown in Fig. 22 can be readily recognized as the prototype of innumerable graphs in the medical literature. This is not a good graph in a sense it does not reflect variation in individual observations, a question which should be *considered in any statistical study but it* does show what appears to be a definite *trend* and it shows it in a way which is easy for the reader to grasp There are many variations possible in this type of diagram It is always essential that the labeling be kept full and clear and not so many lines inserted as to make the diagram hard to follow with the eye.

SELECTION OF SCALE. The scale on which a diagram is constructed is important because it affects the conclusions which the reader will draw Scale must always be considered carefully so that the result will give the reader a visual picture which reflects





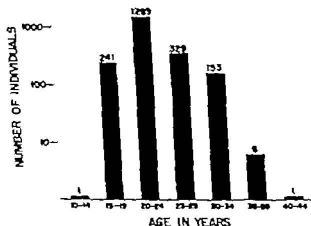
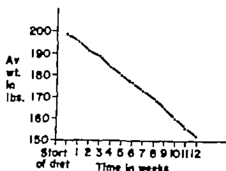
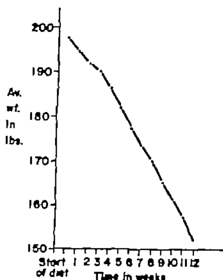


Fig. 4. Typical bar diagrams.

ments in a single patient along a *time* abscissa. In essence it is a graphic history of clinical and laboratory observations on one patient. Presentations of this sort, however almost invariably fail





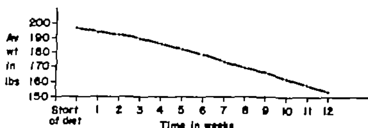
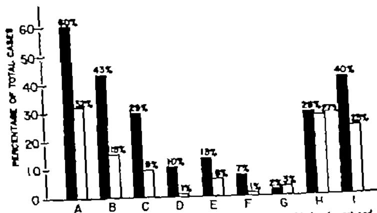


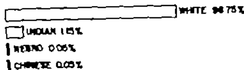
Fig. 23 Diagrams drawn on three different scales to show difference in visual effects.

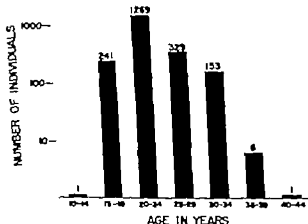
expositions. In scientific medicine and in the biological sciences it is generally considered of restricted value and should be used sparingly A typical example is shown in Fig. 25

Clinical History Diagrams In recent years another form of graphic presentation has become increasingly popular with clinical investigators This consists in showing several develop-



[illegible] in 214 [illegible] (black columns) and 100 controls (white columns). A, [illegible]; B, [illegible]. C, ovarian surgery; D, [illegible]; E, hysterectomies; F, gallbladder surgery; G, thyroidectomies; H, [illegible]; and I, total appendectomies.

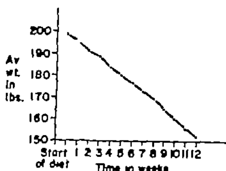


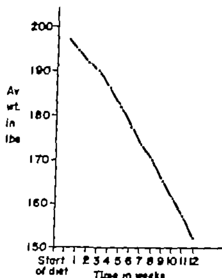


Age and [illegible] distribution of 2000 [illegible]

Fig. 4. Typical bar diagrams.

ments in a single patient along a *time* abscissa. In essence it is a graphic history of clinical and laboratory observations on one patient. Presentations of this sort, however almost invariably fail





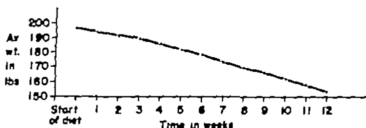


Fig. 23 Diagrams drawn on three different scales to show difference in visual effects

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CLINICAL HISTORY DIAGRAMS In recent years another form of graphic presentation has become increasingly popular with clinical investigators This consists in showing several develop-

examples the method perhaps reaches its greatest heights of confusion in the field of clinical endocrinology.

The graphic representations mentioned are perhaps the most common of those used in medical papers. There are many others which occupy an important place in certain types of problems: histograms, frequency polygons, logarithmic curves, and others, but a discussion of these belongs in a book on statistics rather than one on medical writing. The writer who wishes to delve more deeply into this subject is therefore referred to the list of references in the Appendix (p. 93).

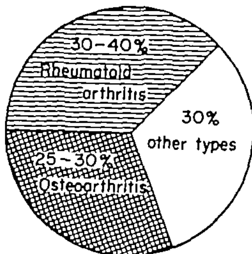


Fig. 25 A pie diagram showing the proportions of all types of arthritis.

Fig. 26. A clinical history diagram showing the hospital course in a case of severe hypertension treated with dibenamine

to fulfill the one most important purpose of the graphic method—ease of interpretation Figure 26 is only one of innumerable

APPENDICES

I. References

The following references have been selected because they may be particularly useful to the medical writer.

General

Canby, Henry S. Better Writing. New York, Harcourt, Brace & Company, 1926.

Charming and helpful, not medical.

Gowers, Sir Ernest. Plain Words. London, His Majesty's Stationery Office, 1948.

Delightful, liberally quoted in this book.

Flesch, Rudolph. The Art of Plain Talk. New York, Harper & Brothers, 1946.

Much common sense about writing; contains chapter on science writing.

Medical

Allbutt, T. Clifford. Notes on the Composition of Scientific Papers. London, Macmillan & Co., Ltd., 1905.

An invaluable book on medical writing, but hard to get.

Fishbein, Morris. Medical Writing. 2nd Ed. Philadelphia, The Blakiston Company, 1948.

A classic; particularly valuable for its suggestions on style.

Hewitt, Richard M. Better Medical Writing: Some Typical Errors and How to Avoid Them. J. Urol., 49:454 (Sept.) 1938.

Short but remarkably valuable discussion.

Statistics

Hill, A. Bradford. Principles of Medical Statistics. 5th Ed. London, Oxford University Press, 1950.

An extremely useful book for any medical or science writer using statistics.

Joint Committee on Standards for Graphic Presentation. Preliminary Report. Quart. Publ. Am. Stat. Assoc., 14:790–797, 1915.

Mainland, Donald. Elementary Medical Statistics. Philadelphia, W. B. Saunders Company, 1952.

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Mainland, Donald. The Treatment of Clinical and Laboratory Data. London, Oliver & Boyd, 1938.

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Mainland, Donald. Elementary Medical Statistics. Philadelphia, W. B. Saunders Company, 1952.
Complete and thoroughly up to date.

Mainland, Donald. The Treatment of Clinical and Laboratory Data. London, Oliver & Boyd, 1938.
A clear and useful discussion.

Pearl, Raymond Introduction to Medical Biometry and Statistics. Philadelphia, W B Saunders Company 1940

An excellent exposition of the subject but rather complex and mathematical for the average medical writer

Miscellaneous

Webster s New International Dictionary Springfield, Mass., G & C. Merriam Company 1947

Webster s Dictionary of Synonyms. Springfield Mass., G & C. Merriam Company 1942.

Dorland's American Illustrated Medical Dictionary 22nd Ed. Philadelphia, W B Saunders Company 1951

Standard Nomenclature of Disease and Operations. Philadelphia, The Blakiston Company 1947

Pepper s Medical Etymology Philadelphia, W B Saunders Company 1949

II. Style for Listing References

Medical periodicals and publishers do not all use the same style in publishing bibliographies Consequently whenever an author knows in advance where his article or book is to be published he should follow the form of that particular publisher For the convenience of many writers two styles are given here

Publications of American Medical Association

1 Forsham, P H Thorn, G W Prunty F T G and Hills, A. G Clinical Studies with Pituitary Adrenocorticotropin, J Clin. Endocrinol., *8* 15 (Jan) 1948

2. Boland E. W Oxygen in High Concentrations for Relief of Pain in Coronary Thrombosis and Severe Angina Pectoris, J.A.M.A., *114* 1512 (April 20) 1940

3 Wiggers, C J Physiology in Health and Disease, ed. 3 Philadelphia Lea & Febiger 1939 p 451

Publications of W B Saunders Company

1 Adams, C J., and Cantwell, W B The Symptomatic Relief of Emphysema Am. J M Sc. *187* 687–692, 1934

2. Baker F L. Management of the Pneumonias J A.M A., *103* 384–387 1938

3 Jones, O F., Carson, L. J., and Hooper A R Recent Advances in Sulfanilamide Therapy Am. J Digest Dis & Nutrition *60* 689–691 1939

4 Smith, W F Surgical Diagnosis and Treatment 2d Ed Philadelphia W B Saunders Company 1943 p 273

III. Common Abbreviations in Medical Manuscripts

alternating current	a-c
Angström units	A
calorie	cal.
centigrade	C.
centigram.	cgm.
centiliter	cl.
centimeter	cm.
cubic centimeter	cc.
cubic foot	cu. ft.
cubic inch	cu. in.
cubic millimeter	cu. mm.
decibel	db.
decigram	dgm.
deciliter	dl.
direct current	d-c
dram	dr
Fahrenheit.	F
foot, feet	ft.
gallon	gal.
gram	gm.
hour	hr
inch	in.
kilogram	kg
kilometer	km.
kilovolt	kv
liquid	liq.
meter	m.
microgram	µg.
micron	µ
millicurie	mc.
milliequivalent	mEq
milligram	mg.
milliliter	ml.
millimeter	mm.
millimicron	mµ
minim.	min.
minute	min.
month	mo
ounce	oz.
pint	pt.
pound	lb
quart	qt.
second	sec.
square	sq.
yard	yd.

IV Proofreaders Marks

Mark	Meaning	Mark	Example
¶	Start paragraph.	¶	read ‸The
no ¶	No paragraph; run in	no ¶	marked / The proof.
⌐¬	Raise	⌐¬	The proof
∟┘	Lower	∟┘	The proof
[	Move left.	[	I The proof
]	Move right	]	The proof
‖	Align type	‖	Three men. Two women.
=	Straighten line	=	The proof
⊙	Insert period	⊙	The proof,
,/	Insert comma	,/	The proof,
:/	Insert colon	:/	The proof‸
;/	Insert semicolon	;/	The proof‸
’	Insert apostrophe	’	The boys proof
“ ”	Insert quotation marks.	“ ”	Marked ‸it proof‸
=/	Insert hyphen.	=/	A proof‸mark.
‸2	Insert inferior figure	‸2	Water H‸O
‸2	Insert superior figure	‸2	$A^2 + B^2 = C$‸
!	Insert exclamation mark.	!	Prove it‸
?	Insert question mark.	?	Is it good‸
(?)	Query for author	(?) was	The proof‸read by
[/]	Insert brackets.	[/]	The‸Jones‸boy
(/)	Insert parentheses	(/)	The proof‸1‸
1/N	Insert 1-en dash	1/N	The proof‸
1/M	Insert 1-em dash.	1/M	The proof‸
2/M	Insert 2-em dash	2/M	The proof‸
□	Indent 1 em.	□	The proof
□□	Indent 2 ems.	□□	The proof
□□□	Indent 3 ems.	□□□	The proof

ℊ	Take out character indicated	ℊ	The prooof.
^	Left out, insert.	h	T proof
#	Insert space.	#	Theproof.
9	Turn inverted letter	9	The proof.
X	Broken letter	X	The proof
⊥	Push down space.	⊥	The proof.
eq # ✓✓✓	Even space.	eq #	A good proof.
⌣	Less space.	⌣	The proof.
⊂⊃	Close up; no space.	⊂⊃	The pro of.
tr	Transpose.	tr	A proof good.
wf	Wrong font.	wf	The proof.
lc	Lower case.	lc	The Proof.
sc	Small capitals.	sc	The proof. The proof.
C+sc	Capitals and small capitals.	C+sc	The proof. The proof.
Caps	Capitals.	Caps	The proof The proof.
≡	Capitalize.	≡	The proof.
ital	Italic.	ital	The proof. The proof.
rom	Roman.	rom	The proof.
bf	Bold face.	bf	The proof. The proof.
stet	Let it stand.	stet	The proof The proof.
out, sc	Out see copy	out, sc	He proof.
spell out	Spell out.	spell out	King Geo

VI Useful Equivalents

Weights and Measures

Weights

APOTHECARIES	APOTHECARIES	METRIC
1 scruple	20 grains	1.296 gm.
1 dram	60 grains	3.88 gm.
1 ounce	480 grains (8 drams)	31.1 gm.
1 pound	5760 grains (12 ounces)	373.24 gm.
METRIC	**APOTHECARIES**	**METRIC**
1 milligram	1/65 grain	0.001 gm.
1 centigram	1/6 grain	0.01 gm.
1 decigram	1 1/2 grain	0.1 gm.
1 gram	15.432 grains	0.001 kilogram
1 kilogram	2.2 pounds avdp.	1000 gm.
AVOIRDUPOIS	**APOTHECARIES**	**METRIC**
1 ounce	437.5 grains	28.35 gm.
1 pound	7000 grains	453.59 gm.
1 ton	2000 pounds	907.184 kilograms

Liquid Measures

AVOIRDUPOIS	APOTHECARIES	METRIC
1 fluidram	60 minims	3.697 cc.
1 fluidounce	8 fluidrams	29.573 cc.
1 pint	16 fluidounces	473.167 cc.
1 quart	32 fluidounces	946.333 cc.
1 gallon	128 fluidounces	3785 cc.
METRIC	**CUBIC MEASURE**	**METRIC**
1 milliliter	0.061 cubic inch	1 cc.
1 centiliter	0.61 cubic inch	10 cc.
1 deciliter	6.1 cubic inches	100 cc.
1 liter	61.0271 cubic inches	1000 cc.
1 teaspoonful	1 fluidram	4 cc.
1 dessertspoonful	2 fluidrams	8 cc.
1 tablespoonful	4 fluidrams	15 cc.
1 wineglassful	2 fluidounces	60 cc.
1 teacupful	4 fluidounces	120 cc.
1 glassful	8 fluidounces	240 cc.

Linear Measures

1 inch	25.4 mm.	2.54 centimeters
1 foot	12 inches	30.48 centimeters
1 yard	36 inches	0.9144 meter
1 rod	198 inches (16 1/2 feet)	5.029 meters
1 mile	5280 feet	1.609 kilometers
1 mm.	0.03937 inch	1000 microns
1 centimeter	0.3937 inch	10 mm.
1 decimeter	3.937 inches	10 centimeters
1 meter	39.37 inches	10 decimeters
1 kilometer	3281 feet (0.62 mile)	1000 meters

Approximate equivalent

Dosages (Approximate Equivalents)

Weights

METRIC	APOTHECARIES
0.0001 gram—0.1 mg	—1/640 grain
0.0002 gram—0.[illegible] mg	—1/320 grain
0.0003 gram—0.3 mg	—1/[illegible]10 grain
0.0004 gram—0.4 mg	—1/150 grain
0.0005 gram—0.5 mg	—1/120 grain
0.0006 gram—0.6 mg	—1/100 grain
0.0007 gram—0.7 mg	—1/90 grain
0.0008 gram—0.8 mg	—1/80 grain
0.0009 gram—0.9 mg	—1/75 grain
0.001 gram—1 mg	—1/64 grain
0.0011 gram—1.1 mg	—1/60 grain
0.0013 gram—1.3 mg	—1/50 grain
0.0014 gram—1.4 mg	—1/48 grain
0.0016 gram—1.6 mg	—1/40 grain
0.0018 gram—1.8 mg	—1/36 grain
0.002 gram—[illegible] mg	—1/32 grain
0.0022 gram—[illegible] mg	—1/30 grain
0.0026 gram—2.6 mg	—1/25 grain
0.003 gram—3 mg	—1/20 grain
0.004 gram—4 mg	—1/16 grain
0.005 gram—5 mg	—1/1[illegible] grain
0.006 gram—6 mg	—1/10 grain
0.007 gram—7 mg	—1/9 grain
0.008 gram—8 mg	—1/8 grain
0.009 gram—9 mg	—1/7 grain
0.01 gram—10 mg	—1/6 grain
0.013 gram—13 mg	—1/5 grain
0.016 gram—16 mg	—1/4 grain
0.02 gram—20 mg	—1/3 grain
0.025 gram—[illegible] mg	—3/8 grain
0.03 gram—30 mg	—[illegible] 5 grain
0.03[illegible] gram—3[illegible] mg	—1/[illegible] grain
0.04 gram—40 mg	—3/5 grain
0.043 gram—43 mg	—[illegible]3 grain
0.05 gram—50 mg	—3/4 grain
0.057 gram—57 mg	—7/8 grain
0.06 gram—60 mg	—9/10 grain
0.065 gram—65 mg	—1 grain
0.07 gram—70 mg	—1 1/20 grains
0.08 gram—80 mg	—1 1/5 grains
0.09 gram—90 mg	—1 1/3 grains
0.1 gram—100 mg	—1 1/[illegible] grains
0.1[illegible] gram—1[illegible]0 mg	— grains
0.[illegible] gram—200 mg	—3 grains
0.[illegible]4 gram—[illegible]40 mg	—4 grains
0.3 gram—300 mg	—4 1/[illegible] grains
0.33 gram—3[illegible]0 mg	—5 grains
0.4 gram—400 mg	—6 grains
0.45 gram—4[illegible]0 mg	—7 grains
0.5 gram—[illegible]00 mg	—7 1/[illegible] grains
0.53 gram—530 mg	—8 grains
0.6 gram—600 mg	—9 grains
0.65 gram—6[illegible]0 mg	—10 grains
0.73 gram—730 mg	—11 grains
0.80 gram—800 mg	—1[illegible] grains
0.86 gram—860 mg	—13 grains
0.93 gram—9[illegible]0 mg	—14 grains
1 gram—1000 mg	—15 grains
1.06 grams—1060 mg	—16 grains
1.13 grams—1130 mg	—17 grains
1.18 grams—1180 mg	—18 grains
1.26 grams—1260 mg	—19 grains
1.30 grams—1[illegible]00 mg	—[illegible]0 grains
grams—2000 mg	—30 grains
4 grams	—1 dram
5 grams	—75 grains
8 grams	— drams
10 grams	— 1/[illegible] drams
15 grams	—4 drams
30 grams	—1 ounce

Liquid Measures*

METRIC	APOTHECARIES
0.03 cubic centimeter	— 1/[illegible] minim
0.05 cubic centimeter	— 3/4 minim
0.06 cubic centimeter	—1 minim
0.1 cubic centimeter	—1 1/[illegible] minims
0.2 cubic centimeter	—3 minims
0.25 cubic centimeter	—4 minims
0.3 cubic centimeter	—5 minims
0.5 cubic centimeter	—8 minims
0.6 cubic centimeter	—10 minims
0.75 cubic centimeter	—12 minims
1 cubic centimeter	—15 minims
cubic centimeters	—30 minims
3 cubic centimeters	—45 minims
4 cubic centimeters	—1 fluidram
5 cubic centimeters	—1 1/4 fluidrams
8 cubic centimeters	— fluidrams
10 cubic centimeters	— 1/[illegible] fluidrams
15 cubic centimeters	—4 fluidrams
20 cubic centimeters	—[illegible] 1/[illegible] fluidrams
25 cubic centimeters	— 5/6 fluidounce
30 cubic centimeters	—1 fluidounce
[illegible]0 cubic centimeters	—1 3/4 fluidounces
60 cubic centimeters	— fluidounces
100 cubic centimeters	—3 1/[illegible] fluidounces
120 cubic centimeters	—4 fluidounces
200 cubic centimeters	—7 fluidounces
[illegible]0 cubic centimeters	—8 fluidounces
3[illegible]0 cubic centimeters	—1 fluidounces
[illegible]00 cubic centimeters	—1 pint
1000 cubic centimeters	—1 quart

*Note: A cubic centimeter (cc.) is the approximate equivalent of a milliliter (ml.). The terms are used interchangeably in general medicine.

Temperature Conversion Fahrenheit to Centigrade

F		+1	+2	+3	+4	+5	+6	+7	+8	+9
	C.	C.	°C.	C.	C.	C.	C.	C.	°C.	C.
0 –	−17.7	−17.2	−16.6	−16.1	−15.5	−15.0	−14.4	−13.8	−13.3	−12.7
10 –	−12.2	−11.6	−11.1	−10.5	−10.0	− 9.4	− 8.8	− 8.3	− 7.7	− 7.2
20 –	− 6.6	− 6.1	− 5.5	− 5.0	− 4.4	− 3.8	− 3.3	− 2.7	− 2.2	− 1.6
30 –	− 1.1	− 0.5	0	+ 0.5	+ 1.1	+ 1.6	+ 2.2	+ 2.7	+ 3.3	+ 3.8
40 –	+ 4.4	+ 5.0	+ 5.5	6.1	6.6	7.2	7.7	8.3	8.8	9.4
50 –	10.0	10.5	11.1	11.6	12.2	12.7	13.3	13.8	14.4	15.0
60 –	15.5	16.1	16.6	17.2	17.7	18.3	18.8	19.4	20.0	20.5
70 –	21.1	21.6	22.2	22.7	23.3	23.8	24.4	25.0	25.5	[illegible]6.1
80 –	26.6	27.2	27.7	28.3	28.8	29.4	30.0	30.5	31.1	31.6
90 –	32.2	32.7	33.3	33.8	34.4	35.0	35.5	36.1	36.6	37.2
100 –	37.7	38.3	38.8	39.4	40.0	40.5	41.1	41.6	42.2	42.7
110 –	43.3	43.8	44.4	45.0	45.5	46.1	46.6	47.2	47.7	48.3
120 –	48.8	49.4	50.0	50.5	51.1	51.6	52.2	52.7	53.3	53.8
130 –	54.4	55.0	55.5	56.1	56.6	57.2	57.7	58.3	58.8	59.4
140 –	60.0	60.5	61.1	61.6	62.2	62.7	63.3	63.8	64.4	65.0
150 –	65.5	66.1	66.6	67.2	67.7	68.3	68.8	69.4	70.0	70.5
160 –	71.1	71.6	72.2	72.7	73.3	73.8	74.4	75.0	75.5	76.1
170 –	76.6	77.2	77.7	78.3	78.8	79.4	80.0	80.5	81.1	81.6
180 –	82.2	82.7	83.3	83.8	84.4	85.0	85.5	86.1	86.6	87.2
190 –	87.7	88.3	88.8	89.4	90.0	90.5	91.1	91.6	92.2	92.7
200 –	93.3	93.8	94.4	95.0	95.5	96.1	96.6	97.2	97.7	98.3
210 –	98.8	99.4	100.0							

NOTE Each of the figures after the decimal point in this table is a recurring decimal. Consequently if rounded off to the nearest tenth of a degree, each decimal figure greater than 4 would be increased by one e.g., 114°F = 45.555 + C., which would be called 45.6 C. (From "Medical Physics" by Otto Glasser Year Book Publishers, Inc., 1950.)

Temperature Conversion Centigrade to Fahrenheit

C.		+1	+2	+3	+4	+5	+6	+7	+8	+9
	°F	F	°F	F	F	F	F	F	°F	F
0 –	32	33.8	35.6	37.4	39.2	41.0	4[illegible].8	44.6	46.4	48.2
10 –	50	51.8	53.6	55.4	57.[illegible]	59.0	60.8	6[illegible].6	64.4	66.[illegible]
20 –	68	69.8	71.6	73.4	75.2	77.0	78.8	80.6	82.4	84.[illegible]
30 –	86	87.8	89.6	91.4	93.2	95.0	96.8	98.6	100.4	102.2
40 –	104	105.8	107.6	109.4	111.2	113.0	114.8	116.6	118.4	120
50 –	122	123.8	125.6	127.4	129.[illegible]	131.0	132.8	134.6	136.4	138
60 –	140	141.8	143.6	145.4	147.2	149.0	150.8	152.6	154.4	156.[illegible]
70 –	158	159.8	161.6	163.4	165.[illegible]	167.0	168.8	170.6	172.4	174.[illegible]
80 –	176	177.8	179.6	181.4	183	185.0	186.8	188.6	190.4	19[illegible]
90 –	194	195.8	197.6	199.4	[illegible]01	203.0	204.8	206.6	208.4	[illegible]10
100 –	[illegible]12									

(From "Medical Physics," by Otto Glasser Year Book Publishers, Inc., 1950.)

VII. Table of χ^2 Probability Scale

Degrees of Freedom	P (Chance of Exceeding Given Value of χ^2)							Degrees of Freedom
	.50	.30	.20	.10	.05	.02	.01	
n	Values of χ^2							n
1	.45	1.07	1.64	2.71	3.84	5.41	6.63	1
2	1.39	2.41	3.22	4.60	5.99	7.82	9.21	2
3	2.37	3.66	4.64	6.25	7.81	9.84	11.34	3
4	3.36	4.88	5.99	7.78	9.49	11.67	13.28	4
5	4.35	6.06	7.29	9.24	11.07	13.39	15.09	5
6	5.35	7.23	8.56	10.64	12.59	15.03	16.81	6
7	6.35	8.38	9.80	12.02	14.07	16.62	18.47	7
8	7.34	9.52	11.03	13.36	15.51	18.17	20.09	8
9	8.34	10.66	12.24	14.68	16.92	19.68	21.67	9
10	9.34	11.78	13.44	15.99	18.31	21.16	23.21	10
11	10.34	12.90	14.63	17.27	19.67	22.62	24.72	11
12	11.34	14.01	15.81	18.55	21.03	24.05	26.22	12
13	12.34	15.12	16.98	19.81	22.36	25.47	27.69	13
14	13.34	16.22	18.15	21.06	23.68	26.87	29.14	14
15	14.34	17.32	19.31	22.31	25.00	28.26	30.58	15
16	15.34	18.42	20.46	23.54	26.30	29.63	32.00	16
17	16.34	19.51	21.61	24.77	27.59	30.99	33.41	17
18	17.34	20.60	22.76	25.99	28.87	32.35	34.80	18
19	18.34	21.69	23.90	27.20	30.14	33.69	36.19	19
20	19.34	22.77	25.04	28.41	31.41	35.02	37.57	20
21	20.34	23.86	26.17	29.61	32.67	36.34	38.93	21
22	21.34	24.94	27.30	30.81	33.92	37.66	40.29	22
23	22.34	26.02	28.43	32.01	35.17	38.97	41.64	23
24	23.34	27.10	29.55	33.20	36.41	40.27	42.98	24
25	24.34	28.17	30.67	34.38	37.65	41.57	44.31	25
26	25.34	29.25	31.79	35.56	38.88	42.86	45.64	26
27	26.34	30.32	32.91	36.74	40.11	44.14	46.96	27
28	27.34	31.39	34.03	37.92	41.34	45.42	48.28	28
29	28.34	32.46	35.14	39.09	42.56	46.69	49.59	29
30	29.34	33.53	36.25	40.26	43.77	47.96	50.89	30

For larger values of n, $\sqrt{2\chi^2} - \sqrt{2n-1}$ may be referred approximately to normal probability scale.

(From Kenney "Mathematics of Statistics," D. Van Nostrand Co. After Fisher by permission of Oliver and Boyd, Edinburgh.)

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